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Thomas A. Edison Papers

A SELECTIVE MICROFILM EDITION

PART II
(1879–1886)

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THOMAS A. EDISON PAPERS

A SELECTIVE MICROFILM EDITION
PART II
(1879-1886)

REEL 47

LITIGATION SERIES (LIT-5)

Court Records
Edison Electric Light Co. v. U. S. Electric Lighting Co.

Edison Electric Light Co. v. United States Electric Lighting Co.

Volume II

Defendant's Proofs and Depositions

T. Cuartin

Circuit Court of the United States.

SOUTHERN DISTRICT OF NEW YORK.

IN EQUITY No. 3445.

THE EDISON ELECTRIC LIGHT COMPANY

vs.

THE UNITED STATES ELECTRIC LIGHTING COMPANY.

ON LETTERS PATENT No. 223,898.

Vol. II.

Defendant's Proofs—Depositions.

DUNCAN, CURTIS & PAGE,
Defendant's Solicitors.

SAMUEL A. DUNCAN,
EDMUND WETMORE,
THOMAS B. KERR,
LEONARD E. CURTIS,
Of Counsel for Defendant.

EATON & LEWIS,
Complainant's Solicitors.

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DEPOSITIONS :

EXHIBITS:

STIPULATIONS:

1601

UNITED STATES CIRCUIT COURT,

FOR THE SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT COMPANY, Complainant *against* THE UNITED STATES ELECTRIC LIGHTING COMPANY, Defendant.	In Equity. No. 3445. On Letters Patent No. 223, 898. 1602

Proofs for final hearing, taken on behalf of defendant, pursuant to the 67th rule in equity, as amended, 1603
before Samuel M. Hitchcock, one of the standing examiners of the said Court.

NEW YORK, January 11th, 1890.

Parties meet pursuant to agreement.

Present—AMOS BROADNAX, Esquire, of counsel for defendant.

CLARENCE A. SEWARD, RICHARD N. DYER 1604
and S. B. EATON, Esquires, of counsel for complainant.

ALBON MAN, Esq., a witness produced on behalf of defendant, being duly sworn and examined by Mr. BROADNAX, testifies as follows:

1 Q. Please state your name, age, residence and occupation.

1605 A. My name is Albon Man; sixty-three years of age; 118 Putnam avenue, Brooklyn; lawyer.

2 Q. What, if any, practical experience have you had in the application of electricity to electric lighting?

A. My practical work upon that matter commenced in the month of January or February, 1878, in connection with William E. Sawyer, and continued with him down to the month of March or April, 1879; subsequently I did some little work in the devising and setting up of an electric lamp, for which I took a patent
1606 which was issued some time in the spring of 1880.

I have been a Director of the Electro-Dynamic Light Company, organized in the summer of 1878, to exploit and carry on the business of electric lighting under the patents of William E. Sawyer and myself, and the several companies organized to succeed the same, and do the same business, up to the present time. I have also been an officer and director of the River & Rail Electric Light Company, organized to do this business, since its organization five, six or seven
1607 years ago.

I have only acted in an advisory capacity with reference to the other companies, other than the Electro-Dynamic Company, not personally doing any work or performing any experiments, but directing and advising in reference to the same.

3 Q. State whether you are the same Albon Man whose name appears as joint inventor with William E. Sawyer in Letters Patent of the United States, No. 205,144, dated the 18th June, 1878, for Improvement
1608 in Electric Lamps:

Also Letters Patent No. 205,305, dated June 25th, 1878, for Regulators for Electric Lights:

Also Letters Patent of the United States, No. 205,303, originally dated June 25th, 1878, and re-issued June 6th, 1882, and numbered 10,134 of re-issues, for Electric Lighting System:

Also Letters Patent of the United States, dated December 10th, 1878, and numbered 210,809, for Improvement in Electric Lamps: 1609

Also Letters Patent of the United States, dated November 19th, 1878, and numbered 210,152, for Improvement in Switches for Electric Lights:

Also Letters Patent dated January 7th, 1879, and numbered 211,262, for Improvement in Carbons for Electric Lights:

Also Letters Patent of the United States dated June 29th, 1880, and numbered 229,335: 1610

Also Letters Patent of the United States dated June 29th, 1880, number 229,476, for Electric Switch.

Also Letters Patent of the United States dated May 12th, 1885, number 317,676, for Electric Lights.

A. Yes.

4 Q. Please state whether you are familiar with Letters Patent of the United States granted to William Edward Sawyer for improvement in electric meters, dated November 19th, 1878, and numbered 210-151; and also the Letters Patent granted to William 1611
Edward Sawyer for Dynamo-Electric Machines, dated February 8th, 1881, and numbered 237,632; and also Letters Patent granted to William Edward Sawyer for Electric Lamps, dated September 16th, 1879, and numbered 219,771.

A. I am.

5 Q. State whether these inventions of Mr. Sawyer were made during the time you were associated with him, and whether the patents were applied for about that time.

A. They were so made while he and I were work- 1612
ing together. The applications for the patents named were all prepared while we were so working together, and I was cognizant of their preparation, and revised the same. Two of them, No. 237,632 and No. 210,151, were filed while we were working together, and the third, No. 219,771 was filed soon afterwards.

1613

6 Q. Please state whether or not during the time you and Mr. Sawyer were associated, the inventions described in the several patents to which I have referred were actually made and put in use by you and Mr. Sawyer, or under the direction of yourself or Mr. Sawyer.

A. They were all made and put in use by us during the time we were working together, from sometime in January or February, 1878, to sometime in March or
1614 April, 1879. Up to the time of the organization of the Electro-Dynamic Light Company in 1878, in the summer of 1878, by us personally, and from that time, by us directing and superintending the work of the Electro-Dynamic Light Company.

All of the aforesaid patents are offered in evidence, as Defendant's Exhibits "Sawyer and Man Patents," and Defendant's Counsel having put in the original patents
1615 mentioned, it is agreed between counsel that Patent Office copies may be substituted for the originals in the record, Defendant's Counsel agreeing to produce the originals at the hearing, in case they are called for by the Court or Counsel.

7 Q. Referring now to the electric lamps made by you and Mr. Sawyer, what material was used by you for the illuminating conductor of the lamps?

A. Carbon, almost exclusively; different kinds of
1616 carbon.

8 Q. Referring now to the lamp described and illustrated in Patent 205,144, please give the dimensions of the carbon illuminant used in that lamp, as nearly as you can recollect it?

A. In length, from a quarter of an inch or less, up to three inches or more; in diameter, from less than one sixty-fourth (1-64) of an inch up to nearly one-tenth (1-10) of an inch; the diameters and lengths

1617

varying, but some of the smaller diameters being of the greatest lengths.

9 Q. Is your last answer true as to the carbon-illuminants made and used by you and Mr. Sawyer in your other lamps?

A. To my best recollection it is as to all of them except as to the shorter lengths.

10 Q. What kind of carbon illuminants were used by you and Mr. Sawyer in these lamps; give the material of which the carbons were made and also the form of 1618
the illuminants.

A. First as to the forms—straight pencils of carbon, V-shaped pencils of carbon, arched-shaped carbons like circular arches, elliptical or loop-shaped arches, arches with varying contour in the general form of the arch as though the line of the arch was laid in waves, and arches of like shape with angular points in the line of the arch, and perhaps other forms; some of the conductors of all these lengths, shapes were, some of them, flat in cross-section, some of them elliptical in cross- 1619
section, some of them round in cross-section, some of them in the form of a trough or U in cross-section, some of them tubular in cross-section and perhaps other forms; these I recollect now; the material of the carbon-illuminants we used was gas-retort carbon, electrically deposited carbon, carbons made by carbonizing fibrous materials, carbons made out of lamp-black, and other carbonaceous materials cemented together by such substances as glue, tar, sugar, etc., and after being
put into shape, carbonized; carbons made of plumbago 1620
treated in a like manner; ordinary pencil leads recarbonized, and I don't know what all; we used all kinds of fibrous substances we could get, such as the different woods and fibres, and strings put into shape and then carbonized; also paper and card-board and ordinary cellulose such as paper stock and papier mache; and the conductors were frequently made of the substances I have mentioned, combined.

1621

Referring back to the forms of cross-section of these conductors, they were not always of the same form throughout the length of the conductors; thus, tubular or U-shaped conductors throughout their main length were sometimes solid, and round, or flat at the ends; and flat conductors throughout their main length were sometime round at the ends, or with enlarged ends, or more widely flattened, or both.

Referring to the last question in regard to the length
1622 of conductors, these in one form of lamp were sometimes from five to eight inches long. I speak from recollection; they were straight, round pencils of cross-section varying from about a thirty-second to a fiftieth of an inch when finished, and were treated by us electrically, and a deposit of carbon made upon them in their whole length; I mean that each end of the conductor was connected and a current of electricity sent through it throughout its whole length, heating it up to high incandescence in a hydro-carbon atmosphere to
1623 cause a deposit of carbon upon it.

11 Q. Do you mean by the last part of your last answer that the carbons were treated according to the process described in the patent No. 211,262, granted to you and to Mr. Sawyer?

A. Yes.

12 Q. Please to mention more specifically the kinds of fibrous materials used by you and Mr. Sawyer in making some of your carbon illuminants.

A. We used papers of various kinds; we used all
1624 kinds of wood that we knew of, or could obtain; we used threads of different kinds, hemp, manilla, flax, jute, cotton, etc., and the separate fibres as they naturally occur in manilla, and jute. I don't know what all we didn't use.

13 Q. Please to give the length and cross-section of these fibrous carbons.

A. I think the longest of them were a little over

three inches in length, I speak only from recollection; 1625
the shortest of them were less than half an inch in length; the cross-section of the largest of them would be a twentieth of an inch, the smallest of them, the cross-section of a natural fibre of manilla or jute of the largest size we could get, I don't know what it would be exactly, but less than a sixty-fourth of an inch; some made of willow wood were somewhere, according to the best of my recollection, from a fiftieth to less than a sixty-fourth of an inch in cross-section. 1626

14 Q. Referring now to the carbon illuminants made of powdered carbon mixed with tar, glue or sugar, or other carbonizable material, how did you proceed to make such carbons, and what was the length and cross-section of them?

A. We mixed up the materials into a thick paste, and rolled them out, between metal plates, for the most part. I also went up to the Eagle Pencil Company and endeavored to have them formed as they made lead pencils, by pressing them through a dye; we also 1627
mixed the material up and put them in a damp powdered state, put them into a case having a follower and put that into a hydraulic press and pressed it down into the form of a thin sheet or cake, consolidating it into a hard substance; these we subsequently carbonized; the sheets made in hydraulic press after carbonization partially, were cut into the shapes we desired, straight pencils or arches, and then re-carbonized, and all of the conductors were finished, by cementing to a lap, like a piece of plate glass or smooth metal and work- 1628
ing them down with files and fine emery paper; they were then usually, if not always, electrically treated according to our patented process, sometimes before being placed in the holders of the lamp, and sometimes after being placed in the holders; and sometimes both before and after being placed in the holders; the length of these carbons was from half to three quarters

1629 of an inch, to the longest, about two inches; their cross-section usually about a twentieth of an inch, but some much smaller—I should think about half that diameter.

15 Q. Are you able to produce a specimen of any of the carbons you and Mr. Sawyer used in your lamps in 1878, and if yea, please do so?

A. I was asked that question by you day before yesterday; by it my recollection was refreshed that in the Spring of 1879, I had of the effects of the Electro-
1630 Dynamic Company two boxes of carbons, which were used by Mr. Sawyer and myself during the fall of 1878, and the winter of 1879, and searching in my safe I found one of these boxes with the carbons in it, such as I and Mr. Sawyer used and of the same kind we used; I mean part of the lot we used out of. I am yet unable to find the other box, but think I have it at my house; I have a lamp, an old lamp, with one of these carbons in it, some inch and a half long, exactly similar to those I now have and produce, but which has been electri-
1631 cally treated and is now of the size substantially of these I produce, showing that before treatment it was less in cross-section than these. I now produce a box containing some of these carbons. They have been in my safe all the time since I got them from the Electro Dynamic Company in the Spring of 1879.

Two carbons produced by the witness, offered in evidence, and marked for identification, Defendant's Exhibit Carbons pro-
1632 duced by Albon Man, Lot No. 1, Jan'y 11th, '90, S. M. H., Ex.

My recollection in regard to the size of carbons used by us has been refreshed by the finding of these carbons; we were never able to get these pencil-carbons so small as we desired, although some were smaller than these I produce, and we were in the habit of working them down on a lap, I think, fully one-half or

more, when we wanted to make conductors of high re- 1633
sistance out of them, and did so very frequently.

16 Q. These carbons that you have produced, have they been electrically treated?

A. They have not.

17 Q. Do you wish to be understood as saying that these carbons were frequently rubbed down on a face plate, or lap, as you style it, and then electricllay treated before they were put in the lamps for use?

A. Yes, cemented to the laps, rubbed down, or filed 1634
down, or both, to less than half their present size, and then usually treated, but sometimes not; almost always treated. This was done in order to make their resistance higher.

18 Q. What was the electrical resistance of the carbon illuminants used by you and Mr. Sawyer in your lamps?

A It was extremely various; I know its lowest limit was less than one ohm. I can only state the highest resistance from recollection of surrounding circum- 1635
stances, and comparative cross-seteion and length of conductors. I place it, thus, as in our higher resistance lamps, from thirty to fifty ohms; but although we measured the resistances, I have no recollection of the results of such measurements. In the treatment of the carbon after they were placed in the holders of the lamps I have reason to think and believe that their resistance before treatment was sometimes double of that, and I think as high as one hundred ohms.—

(The belief and the thought objected to by 1636
Complainant's Counsel.)—

19 Q. I place in your hands an electric lamp; please examine it and state if you recognize it as one of the lamps made by you and Mr. Sawyer?

A. I recognize it as one made by Mr. Sawyer and myself while we were at 94 Walker street in the Fall of 1878, or winter following; it was in my possession

1637 from the time when we left that place in the spring of 1879 until it was placed as an Exhibit in another suit.

20 Q. Is the carbon illuminant still in this lamp?

A. It is in the lamp the same as it was originally put in.

21 Q. Please to give the form, size and resistance of this carbon illuminant?

A. Its length appears to be about five-eighths of an inch, between the holders; its ends are either solid or
1638 tubular, I cannot tell which—probably solid; its total cross-section I judge to be about a twentieth of an inch from outside to outside in its largest diameter; between the ends it is a trough or shell, its cross-section being somewhat like the letter U. The shell appears to be quite thin, about the thickness of over two and less than three sheets of the paper upon which the Examiner is writing; it is made of deposit carbon, deposited by the electrical current upon a fibrous carbon which has been removed after the shell was cut
1639 away on one side; its resistance I cannot tell, but judge it to be only a few ohms, possibly four to ten.

Lamp offered in evidence, same being already marked as follows, "Case 3,472, Defendant's Exhibit Sawyer-Man Lamp No. 2, January 12, 1888, J. G., Jr., Exr.," said lamp being also marked with the docket number of this case, viz.: 3,445.

NEW YORK, January 13th, 1890.

1640 *Direct Examination of* ALBON MAN, ESQ., *continued:*

Present: Counsel as before.

22 Q. Referring now to two specimens of carbon which you have produced, and which you say are a part of a lot of carbons used by you and Mr. Sawyer in your lamps in 1878, please give the length and cross-section of each of these specimens?

A. The longest is a litttle over twelve and a-half inches long, the shortest about eight inches long; their 1641
diameter, as near as I can gauge the same with an ordinary rule-gauge, is a trifle more than a thirty-second of an inch, as near a thirty-second as I can measure.

23 Q. I place in your hands the glass-enclosing globe and the glass base piece, the leading-in conductors, and the carbon-holders of an incandescent lamp; please state if you recognize these several parts as they are here together as parts of one of the incandescent lamps made by you and Mr. Sawyer in 1878? 1642

A. I recognize it as made by us in the fall of 1878 or early Winter of 1879, at No. 94 Walker street. I think the original tubular globe of this lamp, which was somewhat longer than this, got broken, and I substituted this globe, which is one that we used at that time in order to protect the works of the lamps.

24 Q. Is this lamp one of the same type of lamps that is described, illustrated and claimed in the Letters Patent 317,676 issued to you and Mr. Sawyer, May 12, 1885? 1643

A. It is, but parts of this lamp are gone.

25 Q. What parts of this lamp are missing?

A. The binding rings and screws, and most of the carbon illuminant or incandescent conductor, and the cap or cup at the base, and the atmosphere of the lamp, which was a nitrogen vacuum.

26 Q. What do you mean by a nitrogen vacuum?

A. An atmosphere of pure nitrogen greatly attenuated, or attenuated to a degree probably greatly less than air at ordinary pressure. 1644

27 Q. The globe of the lamp being charged, as I understand you, the same substantially as described in the patent No. 210,809, granted to you and Mr. Sawyer, and already put in evidence.

A. Yes, sir, charged and exhausted.

28 Q. Referring now to the lamp put in evidence

1645 yesterday in this case, Defendant's Exhibit Sawyer-Man Lamp No. 2, Case 3,472, and marked also in this case No. 3,445, Jan'y. 11, 1890, please to state whether the enclosing globe of this lamp was also charged and exhausted the same as in Patent 210,809.

A. It was, at the time it was made, the fall of 1878 or winter of 1879.

29 Q. What was the character of the carbon illuminant of the lamp parts of which I have called your at-
1646 tention to this morning, and which I now offer in evidence, the same being marked Defendant's Exhibit Sawyer Man-Lamp for horse-shoe carbon?

A. It's one of those that we made and used with an arched or U-shaped carbon—I mean in its length, the horse-shoe form of carbon or conductor; these carbons were almost all made of fibrous carbon, produced by cutting or making into shape and size, wood, paper, strings, fibers, and then carbonizing them in a closed chamber packed in powdered carbon.

1647 30 Q. Please give the length and cross-section of the horse-shoe form of carbon illuminant in these lamps.

A. Their length varied, between the clamps or conductors, from about three-quarters of an inch to between two and three inches; some, perhaps, longer than three inches: they were most frequently made by us in rings; the ordinary size of these rings was about one inch in diameter; their circumference would then be three inches and three-sevenths of an inch, but a part
1648 of this was clamped by the holders, and the part between the holders was broken away, leaving the incandescent portion rising above the holders somewhat less than three inches outside length; some of these rings were less than an inch in diameter, and some of the incandescing conductors were loops and not rings; the cross-section of the conductors varied from an area equal to the area of a circle of one-twentieth of an inch

in diameter, down to, I judge, ordinarily, a fortieth of 1649
an inch in diameter, and some down to a sixty-fourth of an inch in diameter, or less.

31 Q. What would be the electrical resistance of these carbon illuminants?

A. I don't know; some of those we used in these lamps were, I know, less than one ohm in resistance. I judge that many of them, before treatment by depositing carbon on them electrically, were 50 to 100 ohms
resistance, perhaps higher; I judge that some of them 1650
were frequently from 30 to 50 ohms resistance, after treatment by depositing carbon on them electrically. We measured these resistances, or rather Mr. Sawyer did, and I knew what they were at the time, but I cannot recollect.

32 Q. Please examine the carbon holder in this horse-shoe lamp, so called, and state if you find any portion of the carbon illuminant left between the clamps.

A. There appears to be a piece left between one 1651
pair of the clamps.

33 Q. How long have these clamps which make part of this lamp been in your possession, and where did you get them, and are they now in the same condition as when you did get them?

A. I got them in the spring of 1879 from the workshop of the Electro-Dynamic Company, No. 94 Walker street, this city; they remained in my possession, packed up with other lamps of the Electro-Dynamic Light Co.,
at my place, No. 3 Mercer street, New York city, for 1652
some years; I then moved them to a place I hired in Pacific street, Brooklyn; in the moving most of the lamps, which were packed up in a hogshead, were broken by the hogshead falling down by reason of its hoops becoming loose, and the lamps tumbling down into the cart and on to the street; I packed up what I could out of the wreck and sold some of it for old junk,

1653
and some I took to the garret of my house, No. 118
Putnam Ave., Brooklyn, among which were the parts
of the lamp constituting this exhibit; I should say that
in the muss made by the breakage was lamp-black or
a great number of chemicals and chemical apparatus
by which everything was mussed up and fouled. About
one year ago, now, I went with you (Mr. Amos
Broadnax) to my garret, and looking over the mess and
wreck of stuff there we selected, among other things,
1654 the parts of lamp which were then together, as now ex-
hibited, and brought them over to New York, and this
was put in evidence in another case.
They are in the same condition as when I received
them at 94 Walker street, except that the globe was
broken and another one put on to them; and except
that the carbon conductor or illuminant, which was
probably in and whole when I took it, has been broken
away and the whole thing has been fouled up; of
course I do not know, since I delivered it in the other
1655 case, 3,472, what has been done with it, further than
that I know that it appears to be in the same condi-
tion as when Mr. Broadnax and I took it from my gar-
ret, and the clamps do not appear to have been dis-
turbed, and a piece of the carbon conductor or illumin-
ant was then remaining, I think, in both the clamps;
there appears to be a piece now in only one pair of
the clamps.
34 Q. State, if you know, when the several parts of
the exhibit were made?
1656 A. I think in the fall of 1878.

[Recess for luncheon.]

35 Q. What is the diameter of the fragment of car-
bon illuminant left in one of these clamps?
A. As near as I can measure, a little less than a
thirty-second of an inch; perhaps it may be a fortieth.

36 Q. The diameter would be determined by the dis- 1657
tance between the clamps containing the fragment?
A. Yes. That distance is such that I can crowd five
thicknesses of the paper upon which this testimony is
being taken between the space between the two parts
of the clamp; I did not succeed in getting six in.
37 Q. How many lamps of this type did you and
Mr. Sawyer make in the year 1878?
A. I do not know, a large number of them.
38 Q. How were these lamps sealed? 1658
A. The glass part of the lamp consists of, in the
present case, a tube like a large test tube with a flange
at one end, and the other end closed; what is called
the base of the lamp consists of a round flat disk of
glass, through which the leading-in conductors pass.
The inner parts of the lamp are set up upon this glass
disk. The disk and flange are ground together after
first being made very nearly true until their junction
seemed as transparent as the rest of the glass. Tubular
binding screws of metal pass through the glass disk 1659
having a solid flange on their inside part; the flange
is ground down to the disk by revolving the binding
screw until the metal and disk fit perfectly air-tight.
Outside of the disk a nut threaded upon the bolt is also
fitted tightly to the glass. Between the flange and the
glass, and the nut and the glass, are placed washers,
sometimes of soft metallic foil, and sometimes of thin
paper, in either case the junctions being filled with
Canada balsam sometimes, and sometimes left with
nothing. The nut on the outside was then screwed up 1660
tightly. In the tubes are stop-cocks outside of the nut,
inserted in the bore of the tubes. Outside of the stop-
cocks and soldered to the tubes were lead tubes ex-
tending outward for connections to exhausting appa-
ratus and reservoirs of gas. The interior works of the
lamp having been set up upon the base, were inserted
in the tube. The base and outer end of the flange were
varnished with a coat of Canada balsam and the flange

1661

and base-plate fastened together and thoroughly clamped together by metal rings and' screws. A cushion of paper or wood being interposed between the metal rings and the glass, to prevent fracture of the glass and allow of expansion and contraction by the elasticity of the wood or paper. The junction between the glass base-plate and the flange was then covered with a preparation of tempered sealing wax; this construction is shown in the lamp Exhibit put in on Saturday. This being done the lamp was tested
1662 severely for any leakage by atmospheric pressure and exhaustion. If found perfectly tight, it was then charged and exhausted as shown in the Patent 210,-809. After the lamp was, as we called it, charged, which might be either at an atmosphere of nitrogen gas heated up, and when so heated at the pressure of the atmosphere or thereabouts, or with an atmosphere of nitrogen gas at the highest exhaustion we could obtain, the stop-cocks were turned and their ends and the nuts around the tubes were covered with solder
1663 made quite fusible. The end of the tubes were then filled with solder, and the lead of the lead tube which was in them. A spun-metal cap filled with melted sealing-wax with a small orifice in the end was then put over, all covering the tubular bolts and the glass next the ring and the whole thing, electrical connection being made, however, between the tubular bolts and these covers. These caps were in some cases screw-threaded on to the bolts; the orifice in the caps was sol-
1664 dered up where any existed. The bottom plate between the rings and the bolts was then covered with melted sealing-wax. Over all a spun metal-cap covering all the base and coming up to the top of the rings was placed, filled with melted bees-wax or like substance. I should say that the lerd tubes leading from the binding bolts were pinched together with pincers, before being soldered off.

1665

39 Q. I understand by your last answer that the sealing of this type of lamp was accomplished substantially in the same way as that described and illustrated in Patent 210,209?

A. Substantially; we had a variety of little details in the sealing up of the lamp which were varied from, from time to time, all of which are not mentioned in that patent.

40 Q. What, if anything, did you do, after the base of the lamp was sealed, toward excluding or driving out 1666
the occluded gases from the carbon illuminant, and other internal parts of the lamp—I mean the oxygen or any other carbon-consuming gas that may have been occluded by the internal parts of the lamp—before the final sealing thereof?

A. We heated up the outside of the lamp while the exhaustion was going on, and turned on current of electricity and heated up to high incandescence the carbon conductor; the other parts of the lamp were also heated by this passage of the current to some ex- 1667
tent. After allowing the lamp to stand with an exhausted atmosphere for some time, we repeated these operations after again washing the lamp out with pure nitrogen, the object being to carry these impurities out of the lamp; we frequently repeated these things for several times, meantime closely examining the carbon while illuminated or its image as projected on a screen, and greatly enlarged.

41 Q. Referring now to your method of sealing this type of lamp, and of driving out the occluded gases, 1668
was that method pursued in making all the different types of lamp made by you and by Mr. Sawyer in 1878 and the early part of 1879, or down to the time you and Mr. Sawyer separated?

A. Yes, substantially, the details were not always the same; we made or thought we did, some improvements on them from time to time.

1669

42 Q. Did you, as a matter of fact, as the result of your making and preparing the lamp, in the manner you have described, obtain a stable atmosphere in the lamp in which the carbon illuminant would be enduring when illuminated by the passage of an electric current according to your general system of electric lighting?

A. We did, and succeeded in preserving that atmosphere so perfectly that it seems to be as good to-day as when established in the lamps, in some of the lamps
1670 which I have, after a lapse of ten years.

43 Q. For how long a period would the carbons continue to endure in the state of incandescence at which it was designed that the lamps should be illuminated?

A. I don't know how long they would endure, but some of those we made in October and November 1878, were perfectly good lamps and showed no signs of deterioration or injury when we broke up our shop in the Spring of 1879, and they had been put to very hard usage, run to very high incandescence day after
1671 day, for weeks and even months, almost continually from the time they were made until we broke up the shop in the Spring of 1879.

44 Q. As the result of the experience of yourself and Mr. Sawyer, what conclusion did you and he reach as to practical result of your work in the production of your electric lamps?

Objected to so far as it calls for Mr. Sawyer's conclusion, and as irrelevant and imma-
1672 terial so far as those of the witness are concerned.

A. I know that we produced good, practical incandescent electric lamps, so did Mr. Sawyer; I thought so then, I think so now, and better lamps than many of those that are used to-day commercially: that is, they gave more light, and were run at a higher incan-

descence by us ordinarily than the incandescent lamps 1673
ordinarily in use now.

Adjourned to Tuesday, Jan. 14, 1890, at 11 A. M.

New York, Jan 14, 1890.

Parties meet pursuant to adjournment. Present counsel as before; continuation of the examination of Albon Man.

45 Q. State how you perfected the contact between the 1674
illuminating conductor of the lamps and the electrodes or holders in which the carbons were placed?

A. In some cases where straight pencils were used we bored holes for the reception of their ends in the holders, packed them with powdered carbon wet up with sugar or syrup, or like substance, which, when the current was turned on, was carbonized in connection with the conductor; where arched carbons were used, we placed this same carbon paste between the clamps, 1675
and when they were screwed down, the conductors were imbedded in it, and it was carbonized by the heat of the current when turned on; we also treated them electrically before placing them in the lamps, as shown in our patent 211,262, examining meantime the image of the carbon projected upon a screen of large size; if any imperfection existed in the contacts, this was apparent upon the screen; and the resistance being highest at any point of imperfect contact carbon was deposited there which corrected the difficulty; or if 1676
not, the lamp was taken down, the contacts remedied by adjustment and packing around the ends, and the process of electric treatment was then repeated; we also, in some instances, especially with the arched carbons, short-circuited them by a copper wire close down to the holders, throwing the main part of the illuminating conductor outside of the circuit by reason of its

1677 high resistance as compared with the copper wire, so that the deposit went on, when treated electrically, only at the ends.

46 Q. All this was done, as I understand you, as a part of the construction of the lamp, before the internal parts were put into the containing globe of the lamp?

A. Yes. And after these parts had been set up on the glass base.

1678 47 Q. Referring now to the letters patent granted to Mr. Wm. E. Sawyer for improvement in electric lamps, dated September 16, 1879, and numbered 219,771, please state whether Mr. Sawyer made any lamps according to the description and illu-tration of that patent substantially?

A. He did, while we were at 94 Walker St., in the fall of 1878 and winter of 1879 following.

48 Q. Please produce, if you can, one of those lamps made by Mr. Sawyer at that time?

1679 A. I do, this is one of them.

> The witness produces a lamp and identifies it as the lamp called for by the question. Lamp offered in evidence marked "Defendant's Exhibit Sawyer's lamp."

49 Q. How long have you had this lamp which you now produce in your possession?

A. Since the spring of 1879, when we broke up at 94 Walker street.

1680 50 Q. Was this lamp a part of the assets of the Electro-Dynamic Light Co.?

A. It was, and I purchased it from that company; I first took possession of it as president of that company.

51 Q. Is the lamp now in the same condition it was at the time you took possession of it?

A. It is, except I think part of the carbon illuminant

has been broken off since, and lost out of the lamp; 1681
part of it still remains, and some of the other parts of the lamp have been loosened, displaced or disarranged. It has never been opened since I took it, more than it is now.

52 Q. What are the dimensions of the carbon illuminant now remaining in the lamp?

A. I judge something between an inch and an inch and a half in length; somewhat less than a thirty-second of an inch in diameter. 1682

53 Q. Were these lamps sealed the same as in the case of the other lamps?

A. Yes, substantially the same operation.

54 Q. How was this lamp classified; I mean, is it known as an incandescing lamp, or is it known as an arc-light lamp?

A. It is an incandescing lamp, pure and simple; the occurrence of an arc would destroy its operation for the time until the carbon conductor should be fed up intentionally to make contact with the upper holders 1683
or carbon-rolls by the electro-magnetic apparatus at the base of the lamp.

55 Q. How many of these lamps did Mr. Sawyer make?

A. I cannot at this length of time pretend to recollect numbers definitely; my best recollection would be, or is, that he made while we were at 94 Walker street, from a dozen to twenty lamps substantilly like this, while we were working together; after I ceased to work with him at that place in March, 1879, he went on and 1684
made a set of eight or ten more, which were paid for by the Electro-Dynamic Light Co.

Recess for lunch. Adjourned to 2:30 P. M.

Examination resumed after lunch.

56 Q. Please state what the average length of carbons was that were used in these lamps?

1685

A. About seven inches, six or seven inches; the construction of the lamp provides for the use of a carbon about seven inches long, and of a diameter like the carbon in the lamp.

57 Q. At the time you and Mr. Sawyer ceased to work together, how nearly had you perfected what is known as the Sawyer-Man lamp for use commercially?

A. We had made a large number of the lamps that were good practical lamps, and suitable for commercial use at the time, and that would be superior to any
1686 lamps of the present times in some places and for some purposes for commercial use.

58 Q. Referring now to the two types of lamps made by Sawyer and Man—I mean the straight-pencil lamp and the horse shoe or loop form of carbon-burner lamp—how many of each type did you make that you think would be fairly good commercial lamps?

A. I cannot speak of numbers definitely at this length of time; we had at one time several sets of lamps of from six to twelve lamps in a set, possibly
1687 eight as an average number, of the loop-shaped carbons, that were good practical lamps for commercial use; I cannot recollect the number of sets, but estimate them at from three to five, that were complete at one time and seemed to be good commercial lamps; of the straight pencils we had a great many more, and we made more straight-pencil lamps than loop-shaped. I think we made more than one hundred, and probably over two hundred, of these lamps that proved good and practical.

1688 59 Q. How do you fix the date at which these lamps were made?

A. Mr. Sawyer and I commenced working together at No. 43 Centre street, N. Y. City, on the sixth or seventh of March, 1878; I have a letter from Mr. Sawyer of that date in regard to the premises 43 Centre street, now in the hands of counsel of the Consolidated Electric Light Company, positively fixing that date.

We moved from there to the corner of Howard and 1689
Centre streets in the summer of 1878; from there we moved to the corner of Walker and Elm streets, No. 94 Walker street, the last days of September, 1878, where we occupied at first without lease, rooms which a previous tenant had vacated, and obtained a lease of the premises afterwards in October, from the date of which my recollection is refreshed. In the month of March, 1879, I ceased to work with Mr. Sawyer; this date I fix from the minute- 1690
book of the Electro-DynamicCompany and also from recollection; the dates of the several patents granted to Mr. Sawyer and myself, and of applications for same, refresh my recollection; all the joint work, such as the making of lamps (I do not mean the devising, the planning of lamps), done by Mr. Sawyer and myself was done between the seventh—sixth or seventh—of March, 1878, and the last of March, 1879; Mr. Sawyer continued on at work after I left the shop, and the expenses were paid by the Electro-Dynamic Light Com- 1691
pany for some time and possibly up to the first of May, 1879, when the shops at the corner of Walker and Elm streets were vacated and the work was transferred, under agreement with them, to the shops of the Messrs. Wallace, at Ansonia, Connecticut.

60 Q. How many of the lamps, such as you considered good practical commercial lamps, were made at 94 Walker street between the beginning of October, 1878, and the first of January, 1879?

A. Very much more than were made afterwards. I 1692
estimate some hundreds in number, but the exact number I cannot give; it it proper to state that these lamps were not manufactured at 94 Walker street, that is, no considerable number of them, but were simply assembled, put together and run there, their parts being contracted out and made elsewhere.

61 Q. After your lamps were perfected, as you have

1693 stated, what was done by you and Mr. Sawyer, or the Electro-Dynamic Company, towards the introduction of the invention in practical use?

A. We exhibited them to hundreds of people at our workshops, and in the office room at 94 Walker street, used them for lighting up our shop and office room at evening, and in March or April, spring of 1879, we entered into an agreement, or the Company did, with Messrs. Wallace of Ansonia to manufacture them on
1694 royalty and supply the public with them.

62 Q. How long did you continue the lamps in use for lighting up your shop and office at 94 Walker street?

A. From about the first of our going to 94 Walker street, say in October, 1878, more or less, until March, 1879, last of March, 1879, at evening when it began to grow dusk; we also had several exhibitions of the lamps at evening, when the shops and office room were illuminated by these lamps, from the last of October until
1695 the last of March, and a large number of people were invited to see them at these exhibitions.

63 Q. How long were these lamps continued in a state of luminosity at one time for lighting up your workshop?

A. Two or three hours at a time.

64 Q. And were they used day by day for lighting up your shop, whenever occasion might require their use?

A. Yes, sir; but these occasions were only when
1696 dusk was coming on, at evening; but we ran our lamps for another purpose in the office room continuously day after day, and all day, and into the evening whenever we were there in the evening. That was for the purpose of testing them and their durability.

65 Q. What is the longest time that you recollect of any of the lamps lasting in practical use?

A. I remember one lamp which was made while we

were at 43 Centre street, I think in the month of 1697
April, which we ran day after day there until we left in May or June, which I took to my office when we left, because I had set it up with my own hands, during the summer and until perhaps he middle or last of August. On several occasions I put up that lamp at Jackson's place in Centre street, where I had a dynamo placed, and lighted it up to show to my friends whom I took there to see it, and on one or more occasions I left it running there and re- 1698
turned for it at night before going home from my office. In Aug, 1878, this lamp was taken to Howard and Centre street, and was run there for some weeks whenever anyone wanted to see it; it was finally broken by accident. Of the lamps which we made after going to the corner of Walker and Elm streets, in the month of October, 1878, a considerable number were in good condition and seemed to be perfect when we left there in the spring of 1879. I saw several of these lamps that we made at 94 Walker street while we were there, run- 1699
ning on one or two occasions at a place Mr. Sawyer had in October or November, 1879, I think at West 54th street. They seemed to be in good condition the same as when we left Walker and Elm streets. I was there perhaps an hour or two or three hours on one of these occasions; the lamps were lighted when I went there and remained so when I left. I have some lamps now in which the atmosphere of the lamp remains perfect to all appearance at the present time.

66 Q. Who were the principal assistants of yourself 1700
and Mr. Sawyer in making these lamps at 94 Walker street?

A. Mr. Edward Myers or Edwin Myers, I don't know which, principally, with the assistance of William E. Sawyer and sometimes myself did the setting up, exhausting and charging and putting in the carbons, and sealing up, after we went to 94 Walker st.; Mr. William

1701 — Sawyer, father of William E., and Mr. William Sharp, did the work of assembling the parts of the lamps mostly, though Mr. Myers and Mr. William E. Sawyer also assisted in assembling; new parts or patterns to be sent out were made by Mr. Sharp and Mr. William Sawyer assisted by Mr. William E. Sawyer; George Sawyer, a boy, ran of errands and attended to firing the engine; during the time we were at Howard and Centre streets Mr. William Sawyer worked for us all
1702 the time; I think Mr. Sharp did some work, and I think a workman by the name of Hochausen; Mr. Edwin Myers, of whom I have before spoken, and Mr. Frank Holbrook worked for us there in assembling, setting up and testing lamps and their atmosphere. While we were at 43 Centre street, George Sawyer and William Sawyer were with us; we hired some workmen by the day off and on while we were at 94 Walker street.

67 Q. My question referred only to your principal
1703 assistants in making the lamp in its scientific aspect.

A. Mr. Frank Holbrook, while we were at the corner of Howard and Centre Streets, part of the time, Mr. Edwin L. Myers, there and afterwards Professor Stillman, now of Stevens Institute, did some work for us, having reference to the atmosphere of the lamp. Mr. Myers was the only one that knew all that we were doing.

68 Q. Of the persons whose names you have mentioned, which, if any, of them are now dead?
1704 A. The three Sawyers, father and two sons, and Mr. Myers are now dead.

69 Q. Why did you make the enclosing globe of your lamp in two separate pieces of glass uniting them by grinding and cementing, instead of making the enclosing chamber of one continuous glôbe of glass?

A. The art of electric lighting by incandescence was then new, and we wanted to make a lamp in which, if the incandescing carbon should give out, a new one

could be readily and cheaply substituted, all other 1705
parts of the lamp remaining good, and we did so.

70 Q. Did you make any lamp or lamps whereof the enclosing globe consisted of one single piece of glass, the leading-in conductors being inserted through holes bored in the walls of the glass chamber, the globe having no separate base as in the lamps already put in evidence?

A. We did; some two or three were made under my supervision by Mr. William Sharp in Brooklyn and 1706
several were made by William E. Sawyer or under his direction while we were at 94 Walker Street.

71 Q. What, if any, knowledge did you and Mr. Sawyer have at that time of the making of glass globes of one continuous piece of glass, and of the putting through the walls of such globes leading-in wires or conductors by which an electric current could be passed into the globe through a translating device contained therein?

A. We both of us knew about electric conductors 1707
being passed through and sealed in walls of glass by fusion; we both of us knew what metals were most appropriate for this purpose by reason of their coefficient of expansion being the same or nearly the same as glass; we both knew of the ordinary Geissler tubes in which conductors were sealed in the walls of a glass chamber in which a vacuum was maintained and where a light was produced in the chamber by the passage of electricity through leading-in wires; we 1708
had both of us seen and examined these tubes in various forms; we both of us knew of Crooks' experiments with the radiometer, and had seen the radiometers in which the platinum conductors were passed through and sealed in the walls of a glass chamber by fusion, and in which chambers a vacuum was maintained—a very high vacuum was maintained; we had both read the reports

1709
of Crooks' experiments and seen drawings of Crooks' apparatus, and description of the manner in which it was made, and we discussed these matters, talked them over between ourselves frequently; we adopted the lamp chamber composed of two pieces of glass advisedly and by preference.

72 Q. You have stated that after your lamp was perfected, the Electro-Dynamic Company made a contract with the Wallaces of Ansonia for their manufacture and their supply commercially; now why did the
1710 Electro-Dynamic Company not proceed itself in the manufacture and supply of these lamps and their introduction into public use?

A. By reason of the bad habits of Mr. Sawyer who was the electrician and superintendent of the work and at the same time a large stockholder of the Company, and he was unwilling that anybody else should be placed in charge of the manufacture.

73 Q. What were the bad habits of Mr. Sawyer to which you refer?

1711 A. He was a confirmed inebriate.

74 Q. What was the outcome of the contract with the Wallaces for the manufacture of the lamp?

A. Mr. Sawyer agreed to go to Ansonia and advise
and assist them in the manufacture of the lamps; they
were largely engaged in an electrical work. Mr.
Myers also went with them, (the Wallaces), to Ansonia
to assist in the manufacture of the lamp and other ap-
paratus manufactured by us; Mr. Sawyer's conduct
was so bad after going to Ansonia that the Wallaces
1712 would have nothing to do with him by reason of his
drunkenness and immorality; they finally came to an
open quarrel, and Mr. Sawyer returned to New York in
September, 1879; Mr. Myers was put in charge of the
work by the Wallaces, but was taken sick almost im-
mediately, returned to his home at Plattsburg, New
York, never returned, and died. Mr. Sawyer, after his
return to New York, commenced working upon the

1713
making of the lamps and exhibiting those we had made while at 94 Walker Street, and organized a company called the Eastern Electric Manufacturing Company, which went on for a while with Mr. Sawyer as electrician and superintendent, Mr. Sawyer making strenuous opposition to the Electro-Dynamic Company and its patents, the outcome of all of which was that Messrs. Wallace surrendered their license, and all the patents were sold out and conveyed to the Eastern Electric
Company. The latter made some efforts to introduce 1714
the lamps and other apparatus into use, under the auspices of Mr. Sawyer, but his conduct was such that in the end they sold out and conveyed the patents to the Consolidated Electric Light Company.

Adjourned to meet upon agreement.

New York, January 22, 1890. 1715

Met pursuant to agreement. Present counsel as before.

Examination of Albon Man continued.

75 Q. You have stated that in manufacturing your lamps you frequently took them down, renewed the carbons, and set them up again for further proving and testing. Please state how you sealed your lamps for the purpose of such testing?

A. Whether I have so stated on my present examin-
ation or not I do not remember, but such was the fact. 1716
My description in my testimony in this case of the sealing of the lamps, the soldering up of the stopcocks and orifice of the binding nuts, and the covering of all the joints with a prepared sealing-wax, covering the binding screws with a cap filled with sealing-wax, and covering the whole base of the lamp with beeswax, held in a spun metal cap, covers the final sealing

1717
up of the lamp after it had been thoroughly tested.
To prepare the lamps for testing, we simply connected
the binding tubes, by rubber tubing, joining them to
metal tubes leading to the exhausting apparatus and
to the gas reservoirs, the glass base and flange of
the lamp being varnished with Canada balsam and
clamped together by the binding rings and screws.

After the lamps were charged and exhausted, the
carbons tested, and the lamps were run for trial, the
stop-cocks were turned, covered possibly with a drop
1718 of melted bees-wax, and the lamps put away as com-
pleted, except for finally sealing up. In this condition
they were readily taken down and set up, as I have
stated. Before finally sealing up and covering with
wax, lead tubes were soldered to the binding tubes
leading to the exhausting apparatus and gas reservoirs
and the lamps were re-charged, exhausted and tested
before the final sealing up I have described. The
lamps were considered as completed when they proved
1719 good under the temporary sealing I have described.

Counsel for defendant here notifies counsel
for complainant that he here closes the ex-
amination in chief of this witness, and submits
him for cross-examination.

Cross-examination by counsel for the complainant:

76 x-Q. Referring to your tenth direct question, you
speak of one form of lamp having carbon conductors
which "were sometimes from five to eight inches long."
What form of lamp do you refer to?

1720 A. A form of lamp made by Mr. Sawyer while we were
at No. 94 Walker Street, patented by him or the Electro
Dynamic Light Company, as his assignee, in the spring
of 1879, known as the feeder lamp, of which a sample
is given as exhibit in this case, "Defendants Exhibit,
Sawyer's Lamp, January 14, 1890." The number of
the patent referred to is 219,771, dated 16th day of

September, 1879, application filed April 23, 1879. In 1721
addition to this lamp, we also made, in the spring of
1878, a feeder lamp of a different construction from
this, which was never patented, in which carbons like
the one in this exhibit were used, five or six inches
long.

77 x-Q. What portion of the carbons in these feeder
lamps was in circuit at any one time, and in use as the
burner?

A. The whole length of the carbons was in circuit
partially. Only the part of the carbon was incandes- 1722
cent which was between the upper and lower holders.
The length of the incandescent portion was usually
about from $\frac{3}{8}$ to $\frac{3}{4}$ of an inch, but it varied in differ-
ent lamps, and in some was from $1\frac{1}{4}$ inches to 2
inches in length, or possibly a little longer—I think
not exceeding three inches.

The witness, ALBON MAN, having been pre-
viously examined upon the same general sub-
ject-matter in the case of the Consolidated
Light Company, Complainant, vs. McKeesport 1723
Light Company, then pending in the Circuit
Court of the United States for the Western
District of Pennsylvania (No. 5, May Term,
1888); and the witness having been cross-ex-
amined at great length in that case, it is stip-
ulated by and between the counsel for the
respective parties herein, in order to save
time and expense, that the deposition of the
witness in that case be included herein, with
the same force and effect as if it had been 1724
taken in this case.

Counsel agree that the following portions of
said deposition be omitted, as wholly foreign
to the present controversy:

From x-Q. 90 down to and including x-Q.
295 and the answer thereto. From x-Q. 318 a

1725 down to and including x-Q. 318 d, and the answer thereto. From x-Q 684 down to and including x-Q. 761 and the answer thereto. From x-Q. 765 down to and including x-Q. 897 and the answer thereto. From x-Q. 1,987 down to and including x-Q. 2,088 and the answer thereto. And,

It it is further stipulated that the Exhibits put in evidence, as parts of said deposition,
1726 are to be considered as Exhibits in the present case, excepting where said Exhibits appear to be mere duplicates of Exhibits elsewhere put in the case.

It is also stipulated that a printed copy, with the portions omitted as indicated, may be taken from the printed record in the case referred to, and used as a portion of the original record in this case.

Counsel agree that the following is the deposition of the said Albon Man with the parts
1727 omitted as agreed upon, which is to stand in evidence in this case, as a part of the record herein, to all intents and purposes as if it had been taken in this case, in so far as the same may be applicable upon any issue in the case.

Albon Man's Deposition in the McKeesport Case

1728 Albon Man, being called on behalf of complainant and duly sworn, testifies as follows:

Q. a. What is your name, age, residence and occupation?

A. Albon Man; age, 62 years and upwards; residence, 118 Putnam avenue, Brooklyn; occupation, lawyer. I am also interested in electrical development.

Q. b. Are you the same Albon Man that testified on

behalf of complainant in a certain suit in equity pending in the Circuit Court of the United States for the 1729
Southern District of New York No. 3,553, between the Consolidated Electric Light Co., complainant, and the Edison Electric Light Co., and Thomas A. Edison, defendants?

A. I am.

Q. c. How recently have you read your testimony in that case?

A. Within the last week or so. 1730

Q. d. I place in your hands a printed copy of your testimony in that case. Please to examine it, and state if you recognize it as your testimony?

A. I do; it is a printed copy of my testimony that I have read and referred to in my last answer.

Q. e. Is your testimony in that case, as there printed, a correct copy of the testimony given by you in that case?

A. It is, with certain verbal corrections, of which I have made notes, and which appear in the paper I now 1731
produce, and with the exception of some other slight typographical or clerical errors, or errors in orthography which do not change the sense or meaning (or at least the sense or meaning is apparent in the printed copy), of which I have not made note.

Q. f. Upon what page of this printed record does your testimony begin, and on what page does it terminate?

A. It commences on page 304, and ends on page 924.

Q. g. Are the several answers made by you to the 1732
questions propounded to you as printed in that book, true, and would you, if the same questions were propounded to you, again make the same answer?

A. They are true to the best of my knowledge, recollection and belief. I notice nothing therein to correct, except the errors I have before mentioned. I should make the same answers now as I made then, unless I should find myself mistaken as to any par-

1733 ticular to which I testified in details, by subsequent light being thrown upon the subject as to which I testified.

Q. h. As you are now informed, do you find anything in the answers given by you in this testimony that you want to change, excepting, as pointed out in these notes of correction presented by you.

A. I do not.

Notes of correction offered in evidence, and
1734 marked "Complainant's Exhibit Man's correction of the deposition as printed given by him in Case 3,553," and the Examiner is requested to correct the printed deposition in conformity with these notes.

Q. i. Are you willing to, and do you, as a matter of fact, adopt your deposition in Case 3,553 in said Southern District of New York, as printed in this book, as your deposition in this case?

A. Yes, sir; with the corections I have noted.

1735 Counsel for complainant offers the said deposition of the witness and the exhibits referred to therein as in Case No. 3,553 in the Southern District of New York, in evidence in this case, and the same is marked "Complainant's Exhibit Albon Man's New York deposition, March 27, 1889."

Complainant's counsel give defendant's counsel notice that he shall now proceed to examine the witness, continuing from the end
1736 of his deposition in the New York case.

1737

ALBON MAN'S NEW YORK DEPOSITION.

NEW YORK, April 14, 1887.

Parties met pursuant to agreement.

APPEARANCES:

Messrs. Broadnax & Bull, for complainant.

Messrs. Tomlinson & Dyer, for the defendants.

ALBON MAN, a witness produced on behalf of the complainant, being duly sworn and interrogated by Mr. Broadnax, testified as follows:

1 Q. State your name, age, residence and occupation. 1738

A. My name is Albon Man; my residence is 118 Putman avenue, Brooklyn; I am a lawyer by profession, and my age is sixty years.

2 Q. Are you actually engaged in the practice of the law, or have you any other occupation?

A. I am engaged in law practice and also in electrical work.

3 Q. What is the nature of the electrical work upon 1739 which you are engaged?

A. The manufacture of electrical motors, storage batteries, and the electric light, with the devising of plans and apparatus for the use of electricity in power and light, and for the methods of producing electrical currents cheaper.

4 Q. How long since you first turned your attention more especially to electrical work?

A. To electrical work proper in the month of January or February, 1878. Before that time from about 1740 the year 1866, I had made electricity a special subject of study for information and pleasure, but not for work.

5 Q. Since January or February, 1878, about how much of your time has been given to electrical work, and to what extent have you followed up the progress of the application of electricity, more especially to electric lighting and other kindred subjects?

1741 A. During all the year 1878, and up to the spring of 1879, I was actively engaged in electrical work for electric lighting with Mr. William E. Sawyer. From that time forward until the fall of 1882, I was not actively engaged in any electrical work; but since that time until the present I have been a director of the Consolidated Electric Light Company, and having taken an active interest in its work, but not myself participating in the doing of any work, only acting in an advisory or directing capacity. For the past two
1742 years or more I have been President of the River and Rail Electric Light Company, and having given a good share of my time to the electrical work of that company.

6 Q. Are you the same Albon Man whose name is mentioned as joint inventor and patentee, in the patent in suit, No. 317,676, dated May 12, 1885, and also in the Letters Patent of the United States 205,305, dated June 25, 1878; Re-issued Letters Patent No. 10,134, dated originally June 25, 1878—the re-issue being
1743 dated June 6, 1882; also Letters Patent No. 229,476, dated June 29, 1880; also Letters Patent No. 210,152, dated November 19, 1878; also Letters Patent 211,262, dated January 7, 1879; also Letters Patent 229,335, dated June 29, 1880; also Letters Patent 210,809, dated December 10, 1878; all of which appertain to the practical application of electricity to electric lighting and to apparatus appertaining to the production of electric lights and the regulation thereof?

A. I am. I have taken out one or two patents be-
1744 side these, myself, appertaining to the same subject.

7 Q. Referring now to the patent in suit, a copy of which I place in your hands, please to read the first claim of that patent and state when the invention or improvement covered by that claim was made?

A. In the spring of 1878, in the month of March or April.

8 Q. Was that invention actually reduced to practice at that time? 1745

A. It was.

9 Q. What kind of fibrous or textile material was used by yourself and Mr. Sawyer in reducing that invention to practice?

A. At that time, March or April, 1878, principally paper and wood of different kinds, and probably jute and manilla. As to the jute and manilla my recollection is not so distinct in regard to their use in March 1746
and April, 1878, as in the months of September and October, November and December, 1878, all of them, we used paper, a great variety of woods, jute, manilla, cotton threads, broom corn, and a great variety of other substances of fibrous, or textile material; and the broom corn, as I now recollect, we also used in the spring, 1878. I think jute and manilla were also used in the spring. The paper and wood were positively used in the spring, but I am not so certain of the jute 1747
and manilla.

10 Q. Please to enumerate some of the different kinds of wood you used in the spring of 1878, and also the different kinds of paper used by you during the same time?

A. First, as to the woods; we carbonized a great variety of woods in the spring of 1878, among which were, willow, maple, birch, elm, hickory, lignum vitæ, poplar, and others that I do not recollect distinctly. We got all we could find. I remember one thing that we did in the spring of 1878, but I do not remember 1748
the material. We carbonized some endogenous woods, but what they were I do not recollect. We had a particular object in doing it. I do not recollect whether we used any canes, but we did use what strikes me as some of the palms; but I do not recollect what; whether it was reeds, or cocoanut or palm woods, or what it was I do not recollect. All I know is we did it.

1749 The fibres of such woods interlace, and we had an idea that such a wood might make a stronger carbon. The fibres of endogenous woods, to some extent, interlace.

Now, as to the papers: we carbonized a great variety of them, but fell back on ordinary white blotting paper, and I should say manilla paper, and we got some strong bond paper, linen papers—pure linen papers—and ordinary blotting paper. We used a good deal of bristol board and a good deal of drawing pa-
1750 per. We had ordinary drawing paper and also cards; we cut up cards; we used a card paper; but, as I say, we fell back upon ordinary white blotting paper which was nearly pure celloluse.

11 Q. Referring now to the carbons made by you and Mr. Sawyer, of wood, in the spring of 1878, please to state how you made those carbons, and of what form you made them?

A. At first we carbonized the wood en masse and sawed and cut straight pencils of carbon out of them
1751 and turned rings out of the charcoal on a lathe by first turning up a cylinder, boring it to make a tube, and cutting a ring off from the end of the tube so formed. After a few experiments of this kind, we adopted the plan of cutting the wood down substantially to the size of the carbon we desired and bent it to shape and then carbonized it. Some of the wood that we used was already in fine filaments or strings—such as excelsior, used as a packing material and for stuffing cheap mattresses. It only required to be smoothed up, softened
1752 and bent before carbonization. Some of the wood was in the form of veneers, cut extremely thin in sheets, from which we cut out the shapes we wanted, and then smoothed them up and corbonized them. The forms were straight pencils, loops and arches.

12 Q. As to the paper, how did you make your carbons of that?

A. At first we carbonized the paper in sheets; some-

times several sheets stuck together and pressed, from 1753
which, after carbonization, we cut out pencils and arches. After making a few carbons in this way, we cut out of the paper before carbonization various forms —straight pencils with enlarged ends, straight pencils with pointed ends, arches and loops, some of the arches having angular forms in them, some of them waving forms, some of them small crosses and stars in their length; and after cutting them into shape we placed them in boxes and crucibles in powdered carbon or plumbago, or both, in alternate layers of the carbon 1754
powder and of the papers or other substances to be carbonized, until the boxes were filled. They were then pressed down, covered up and the covers fastened down, then placed in the fire and heated until carbonized. After being carefully cooled, the boxes were opened and the carbon taken out.

The wood carbons were carbonized in the same manner.

We frequently worked the carbons down and smoothed them off after taking them from the box. We 1755
also soaked them in sugar in some instances, and frequently when we did so re-carbonize them in a box or crucible.

I have omitted to state that the ends of paper and wood carbons in the loop and arched forms were usually enlarged where they were to be attached to the conductors, but not always. In some of the wood carbons that we made of thin veneers, I think of rosewood and mahogany, we worked the wood down into extremely thin and tenous sheets on a lap, or fine em- 1756
ery paper, cemented to a lap, and put several of the sheets together, in some instances with glue and in some instances with sugar, so that the fibre of the wood would run in different directions, and after they were dried would cut pieces for carbonization of all kinds and shapes from them.

By the word "lap," I mean a smooth, even-surfaced

1757

face plate, on which the carbons were laid and worked. In some instances we used plate glass for a laps or face-plate.

13 Q. Please to desribe a little more fully how you arranged the wood and paper for carbonization in the boxes, and desribe more fully the boxes themselves.

A. We used at first iron boxes about three by four inches in size and two inches deep, with iron covers.
1758 These were mostly of heavy wrought sheet metal, with cover. Some of the first were too thin, and we burned them up. We also had one or more of cast iron, with cover. We used these boxes up, and then I got a sand crucible to do it in, with cover. We at first simply wired the boxes and covers together by winding them with wire. Afterwards we luted them with fire-clay in the angles and around the cover. We also luted on the covers of the crucibles, leaving a small orifice in each case for the escape of gases.

1759 We began the preparation for putting the carbons in by putting a layer of powdered carbon or plumbago in the bottom of the box or crucible and pressing that down smooth and hard. We then put in the articles to be carbonized, sometimes bending the paper or wood in the shape we wanted it, and pressing it into the carbon edgewise. We then sifted more powdered carbon or pumbago into the box or crucible, until the articles were covered, when we again pressed it down and smoothed it off; packed in some more articles in
1760 the same way, sifted on more carbon, pressed it down, smoothed it off; put in more articles, and so on until the box was filled, the final layer being a thick layer of powdered carbon pressed down solid, on to which the cover was pressed down.

14 Q. What, if any other method, did you use in carbonizing these wood or paper carbons?

A. Well, by way of experiment, we filled the paper before it was cut to the size that we wanted it, with

plumbago, and polished it, rubbed it down and pressed it, and then cut it to size and put it into our lamps in an atmosphere of hydro-carbon, and passed a current through it to carbonize it. We also, by way of experiment, filled the paper with sugar of lead and other mineral salts of easy reduction—I think one of them was nitrate of silver—soaking them in solutions of the salts, and after drying them and exposing them to an atmosphere of some sort, to partially reduce the mineral salts, to make them conductors we carbonized 1762
them in the same manner in the atmosphere of hydro-carbon, but these were only experiments, and we did but little of it.

The first experiment with paper was made in the open air, by filling a crease in the paper with plumbago and passing the current through it. Afterwards we filled the paper with plumbago, pressed it, cut it into strips, passed the current through it, and burned it up. These were our first experiments made in March, 1878. This was followed at once by the carbonization in 1763
boxes, as I have already described; that being the plan adopted in April, 1878, of making our carbons.

15 Q. Please to give, as near as you can, the lengths and sizes of carbons made by you, as you have described?

A. The carbons that we made of excelsior were as fine as those I now produce, which is a little less than the thirty-second of an inch in diameter. The broom corn was about the same size as that I now produce, or a little less. Our carbons were from that size or less up 1764
to an eight of an inch. The different sizes varied in length, for the reason that we had not sufficient electromotive force to force a current through the smaller carbons and heat them up to incandescence. The longest were about two inches, possibly over two inches; and the shortest were down to, I should think from recollection, a quarter of an inch. I should think somewhere about a quarter of an inch. Those we made

1765 from willow twigs were split and shaved down, the pith being taken out, and the bark off and only the wood used. With the exception of the excelsior, our wood carbons were wider than they were thick, and our paper carbons were usually wider than their thickness. They were from a sixty-fourth of an inch up to a twentieth of an inch in thickness. Possibly some of them were thinner than a sixty-fourth, were made of single sheets of paper. The excelsior which I now produce is in
1766 bad condition, and that which we used was selected, as was also the broom corn, the specimens being merely produced to give an idea as to the size and kind of material. I also produce samples of manilla fibre and of broom corn, such as we carbonized.

The specimens of excelsior, manilla, and broom corn, produced by the witness, are offered in evidence, and are marked

"Complainant's Exhibit, No. 26 Excelsior, Broom Corn and Manilla, produced by Albon
1767 Man, New York, April 14, 1887."

16 Q. What, if any, means did you take to keep the carbons in shape during their carbonization?

A. At first, we tied them in shape with very fine wire wherever they were bent. Where they were cut into shape of loops or arches, they did not require that. When they were bent in they required fastening; sometimes they were fastened by being pressed into the powdered carbon. Subsequently, in the fall, we got a
1768 block of carbon and bent them over that and fastened them to the block with clamps, and carbonized them in that way.

17 Q. What use did you make of these carbons about which you have been testifying?

A. We used them in our lamps, for the purpose of making the incandescent conductor of an electric light.

18 Q. These carbons, as I understand you, you commenced to make in March, 1878, and continued it 1769
throughout the fall of the same year, and the winter of the following year?

A. We did, for the same purpose. And we used them for the purposes for which they were made.

19 Q. What, if any treatment, did you give the carbons subsequent to their manufacture, as you have described.

A. We usually—and almost always—treated them by 1770
a process which we patented, of heating them up to high incandescence in an atmosphere of hydro-carbon liquid or gas. That was a process supplemental to the making of the carbon. We frequently, but not usually, used them in our lamps without treatment. I mean by that that a great many more of them were treated than were used without treatment. We got a better carbon by treating them, and intended to practice that method of treating them after having manufactured the carbons. We not only got better carbons, but we were able by 1771
that process to regulate its resistance, so as to make the carbon in itself uniform in resistance throughout its length, or nearly so, and at the same time to make one carbon of the same reistance as another.

20 Q. Why did you make your carbon of various lengths and sizes as you have stated?

A. We were experimenting to ascertain which was the best carbon for us to use, with the means at our command. Where we wanted a carbon of high resistance, therefore, we made it small and long. Where of 1772
low resistance, larger or shorter, or both.

21 Q. Is that the method usually adopted for obtaining lamps of high or low resistance, the kind of carbon remaining the same?

A. It is one of the methods. The resistance might also be varied in the same material by the carbonization being carried to a higher degree, or at a higher

1773 heat, or at a lower heat. The resistance was also varied by the extent and manner of treatment subsequent to the making of the carbon

22 Q. What, if any difference, is there in principle between a high resistance carbon and a low resistance carbon? I mean carbons of the same material. What is the difference in the making of carbons of a high or low resistance, and what is understood by a high resistance and low resistance? In other words, what is
1774 a high resistance lamp, and what is a low resistance lamp?

A. To the first part of the question, I would answer that carbons of uniform section and of the same character and density of carbon, vary in resistance, directly as their length. Double the length, double the resistance, other things being equal. Of the same material, the resistance is decreased as the square of the diameter is increased. This is simply an electrical principle, applicable to all substances which are conductors,
1775 and is well known to all electricians. I know of no difference in principle as to resistance peculiarly applicable to carbons?

As to the second branch of the question, it is simply to make the material to be carbonized of the proper size and length for the resistance required, and to carbonize and treat it properly. There is no fixed point where a lamp, or the incandescent portion of the lamp, in and of itself, can be said to be of high resistance or low resistance. The resistance may be made anything al-
1776 most that is required from two or three hundred ohms down to a fraction of an ohm. The lamp must be made to suit the current applicable. If a current of high electro-motive force is available, then the lamp may have a high resistance corresponding to the electro-motive force. If the current available is one of low electro-motive force, the resistance must be reduced until sufficient current will pass through the incandes-

cent conductor to heat it up so as to give the required light. 1777

It has been said that a great economy can be made by using lamps of at least one hundred ohms resistance. I do not think that any fixed resistance is yet determined upon. It is a question of the current available, the proximity of the lamp to the source of electricity, or its remoteness therefrom, and other resistances in circuit and other circumstances, as well as of resistance. A lamp of very low resistance, even less than an ohm, might be 1778
the most economical one, in my judgment, in one position, and for a given amount of light, and with a given current; and a lamp of over 100 ohms might be the better one and most economical one, under other circumstances.

I intend to say that there is no point agreed upon among electricians at which high resistance begins and low resistance ends. The expression is purely comparative.

23 Q. Referring now to the second claim of the pat- 1779
ent in suit, state, if you please, when the invention, or improvement, covered by that claim, was made?

A. In March or April, 1878, at the same time the other was. It was put in practice by Mr. Sawyer and myself at that time at No. 43 Centre street, in this city. It was continued in practice all through our work, so far as I knew in regard to it, up to March or April, 1879, and, as I believe, by Mr. Sawyer from that time forward until the forming of the Consolidated Electric Light Company, in the fall of 1882, and from the fall 1780
of 1882 by the Consolidated Electric Light Company until this day.

24 Q. Referring now to the third claim of the patent in suit, when was the invention or improvement, covered by this claim, made?

A. At the same time, and in the same manner which I have already described.

1781

25 Q. Referring now to the fourth claim of the patent in suit, please to state when the invention, or improvement, covered by that claim, was made?

A. At the same time, in March and April, 1878, and put into operation by Mr. Sawyer and myself at No. 43 Center street, at that time; and it was continued in use from that time on down, by ourselves and our successors, and it is now in use by the Consolidated Electric Light Company.

1782 Adjourned to Friday, April 15, 1887, at 10 A. M.

NEW YORK, April 15, 1887.

Parties met pursuant to adjournment.

APPEARANCES:

Messrs. Broadnax & Ball, for the complainant.

1783 Messrs. Tomlinson & Dyer, for the defendants.

ALBON MAN.

Examination continued by MR. BROADNAX:

26 Q. You have stated in your previous answers, that in the preparation of the paper for carbonization in some instances you saturated, or filled, and rubbed into it pulverized plumbago, and also mineral salts, please to state definitely why you prepared the paper
1784 in that way?

A. I have explained that our first carbonization was done by a current of electricity. The paper was a non-conductor. In order to make it a conductor, so that a current could be passed through it, we filled it and covered it, as I have explained, with pulverized plumbago, simply for the purpose of making it a con-

1785

ductor. We used the mineral salts for the same purpose, but did not like the mineral salts, and did very little with them.

After having found that the paper filled with powered plumbago before carbonization became a conductor we continued in some instances, but not always, nor usually, to fill the paper with plumbago before carbonization in the boxes, in order to reduce the resistance of the loops and carbons, after they were carbonized, so that we could pass a current through them
to light them up, as we had no very high electro-motive 1786
force dynamos, and no available current of a high electro-motive force.

The practice we adopted in April, 1878, was to carbonize the papers without any such treatment before putting it in the boxes and covering it with powdered carbon or powdered plumbago, as I have explained, to protect them while being carbonized. In other words, we carbonized the paper without any preparation beyond that of cutting it to the desired size or form.

27 Q. Did you ever treat any carbon made from 1787
paper or wood with plumbago after carbonization?

A. No; we never did.

28 Q. You have stated that it was your usual practice to treat the carbons after carbonization in the presence of hydro-carbon gas—for the purpose of bettering the carbons and equalizing their resistance. Is the process referred to by you the same as that described in your Patent No. 211,262, granted January 7, 1879?

A. Yes; it is the same process described in the 1788
specification of that patent.

29 Q. What proportion of this wood and paper carbons, made and used by you, were treated by the process referred to in the patent mentioned in my last question?

A. I could not give any definite proportion. All I

1789 can say is it was our usual practice to treat them after carbonization, but that some of them were used without such treatment. The number of untreated carbons was small in comparison with those that were treated.

30 Q. Where is Mr. Wm. E. Sawyer now?

A. He is dead.

31 Q. State, as near as you can recollect, when he died?

A. I should think it was four or five years ago. I
1790 think he died in the Summer of 1883. It may have been a year later that he died.

32 Q. Do you know, and if so please mention them, of any statements in writing to which you can refer, and by which you can fix the date certainly of the making and reducing of the invention to practice covered by the several claims of the patent in suit?

A. There was an agreement between Mr. Sawyer and myself, contained in a small memorandum book which has been mislaid or lost. That agreement was dated
1791 February 15, 1878, and was referred to by me and quoted in my testimony in the Interference between Thomas A. Edison and Sawyer and Man, about the invention of the patent in suit. Its exact words are given at page 201 of a certified copy of Sawyer and Man's supplemental proofs in that Interference. The agreement was in the words and figures following:

"Advances to William E. Sawyer on account of ex-
"periments in electric lighting, made by Albon Man,
"and not to exceed in amount $250, and to be returned
1792 "by Sawyer within fifteen months from date, in case
"that Man is not satisfied to go on after seeing result
"of preliminary experiments, for which these advances
"are made. Dated February 15, 1878. (Signed) W.
"E. Sawyer." I quote the above from the book referred to.

In addition to this agreement there followed a second agreement, dated March 19, 1878, which I now produce.

The agreement is offered in evidence by complainant's counsel and marked "Complainant's Exhibit No. 27. Agreement between Sawyer and Man. March 19, 1878." 1793

THE WITNESS.—There was also an agreement between Mr. Sawyer and me about some inventions, dated May 11, 1878, which I also produce.

The agreement is offered in evidence by 1794
complainant's counsel and marked "Complainant's Exhibit No. 28. Agreement between Sawyer and Man, May 11, 1878."

THE WITNESS.—These agreements are handed to me by Mr. Broadnax, counsel to the complainant, for production in evidence here, the same having been, and still are, in his custody.

Counsel for defendants consents that type-
written copies of these agreements may be 1795
substituted for the originals and used in evidence with the same force and effect as the originals, counsel for the complainant agreeing to produce the originals in case any exigency may arise, making it necessary to do so.

33 Q. In whose handwriting is the agreement of March 19, 1879?

A. In my own.

34 Q. It is signed by you and Mr. Sawyer?

A. It is. 1796

35 Q. Mr. Sawyer signed it in your presence?

A. He did.

36 Q. In whose handwriting is the agreement of May 11, 1878?

A. In the handwriting of William E. Sawyer.

37 Q. And that is also signed by you and Mr. Sawyer?

A. It is. It was signed by him in my presence.

1797 That agreement of the 11th of May, 1878, it is proper to say, was prepared by Mr. Sawyer himself, and upon his own suggestion, made long before the date of the agreement. He talked with me about it often, and said he would prepare such a paper, and did so, and we both signed it.

38 Q. Do these agreements refer to, and include the invention covered by the patent in suit?

A. The first agreement of February 15th, 1878, refers to inventions of Mr. Sawyer alone, and would only
1798 cover this matter had it been the sole invention of Mr. Sawyer. The second agreement of the 19th of March, 1878, does not, in exact words or terms, refer to the invention which is the subject matter of this suit; but prior to this, before the 19th of March, 1878, experiments had been made in the matter. At the time of the third agreement, dated May 11, 1878, the invention had been completed, and is included in that agreement, and was intended so to be.

39 Q. The paper of May, 11, 1878, mentions three
1799 joint inventions, namely: Electric lamps, regulators for electric lights and electric lighting systems, and other apparatus and inventions now under consideration. Under which of these heads was included the invention covered by the patent in suit?

A. Under both of them. At the time the paper of May 11, 1878, was made, we had already completed our electric lamp, our regulator, and our lighting system, and were considering further improvements upon them, and the carbon which makes the principal
1800 subject matter of the patent in suit and the combinations covered by the several claims, had also, been made before that agreement, and were mostly completed before the end of March, as I now recollect it; certainly before the end of April, 1878. I started in with Mr. Sawyer, with him as sole inventer; but Mr. Sawyer producing nothing practical, I commenced to work with him, and from that time we worked together

in the production of these inventions. We worked 1801
together from the 6th or 7th of March, 1878, that being the date when we went to No. 43 Centre street. But the realization that what was produced and done was a joint invention, or joint inventions, as matter of law, did not come to us until after the execution of the agreement of March, 19, 1878. It was the consideration of the subject matter of taking out patents referred to in that agreement that brought us to consider the legal question that what was produced was, as mat- 1802
ter of fact and law, joint invention.

40 Q. Is it or not true that from the time that you and Mr. Sawyer started in to work upon electric lighting, at No. 43 Centre street, in the early part of March, 1878, the inventions made and patented by you and, him jointly were the joint productions of both of you, working together for a common end?

A. It is true that they were our joint productions as I have already stated.

41 Q. Can you produce any incandescent electric 1803
lamp, or part of such lamp, made in the spring of 1878, in which these carbons were used, about which you have been testifying, of filaments of paper and wood?

A. I now have and produce a glass globe of an incandescent electric lamp which I myself had made at a glass factory in the Eastern District Brooklyn, in the latter part of March, or 1st of April, 1878, and which I have had in my possession, first as an individual, and second as President of the Electro Dynamic Company, until the spring of 1876, when I 1804
took it into my own possession as a sample of one of our globes. It has remained in my possession ever since that time until recently, when I brought it and gave it to Mr. Broadnax, the complainant's counsel. The lamp is peculiar in having a particular size and shape, but more particularly from the fact that the flange of the lamp was made of a separate piece of

1805 glass and put on in a melted state upon the globe proper.

In the month of April or May, 1878, and before we left 43 Centre street, we got a mould for making the flange upon the glass at the same time as the making of the globe and ceased to have the flange put on with a separate piece of glass.

I distinctly recollect the use of the paper, wood and other fibrous carbons in the form of lamp, the globe of
1806 which I produce. We did not have any lamp globes made after leaving 43 Centre street, in which the flange was made of a separate piece of glass fused on to the globe.

The lamp globe produced by the witness is offered in evidence by complainant's counsel, and is marked "Complainant's Exhibit No. 29, globe of lamp produced by Albon Man, April 15, 1887."

1807 Adjourned to Saturday, April 16, 1887, at 1 o'clock P. M.

New York, April 16, 1887.

APPEARANCES.

Messrs. Broadnax & Bull, for the complainant.
1808 Messrs. Tomlinson & Dyer, for the defendants.

Parties met pursuant to adjournment.

Albon Man.

Examination continued by Mr. Broadnax.

42 Q. I understand from your testimony that the inventions covered by the patent in suit were made and

embodied in the lamp that is referred to in the paper 1809
of May 11, 1878, as one of your joint inventions previous to the making of that paper. Am I correct in my understanding in that particular?

A. You are.

44 Q. How long before this paper was made were the inventions of the patent in suit reduced to an operative condition as part of an incandescent electric lamp?

A. The carbons being the subject matter of contro- 1810
versy in this suit, made of paper, wood and other fibrous substances, were made and put into the lamps and used, to the best of my recollection, some time in the latter part of March. It may have been the forepart of April, 1878.

45 Q. And the lamp globe that you have produced here and put in evidence as Complainant's Exhibit No. 29, is a part of such incandescent electric lamp, as I understand you?

A. It is. 1811

46 Q. What kind of a bottom was used in connection with, or as part of the enclosing chamber of this lamp?

A. At first the bottoms were made of plate glass perforated to admit the passage of the conductors. This was an expensive method, and we at once got a mold for maki g the bottoms with perforations through them, directly from the glass-pots in the glass factory. And after we got that mold, which was in March, I think, 1878, we used the glass bottoms made with the 1812
molds. They were similar to the one I now produce, but of a size adapted to the lamp, Exhibit No. 29, which I have produced.

47 Q. Can you produce any of the glass bottoms suited in size to lamp Exhibit No. 29, referred to in your last answer?

1813

A. I do not know. I think so. I will look, and if I can find any, I will produce them. I had some.

48 Q. State, if you know, who made this glass globe your Exhibit No. 29?

A. I had globes like them made at two glass factories in the Eastern District, Brooklyn. I cannot identify which one, nor can I give the names of the owners of the factory at present. I might find them.

49 Q. State, if you know, whether this globe, Exhib-
1814 it No. 29, was blown directly from the pot in the glass factories?

A. It was. I was present at the making of a great number of the globes. I waited at the glass factories to have them blown and made, and saw them made.

50 Q. After you and Mr. Sawyer went to 43 Centre street, in March, 1879, did you and Mr. Sawyer make any lamps wholly of glass in which the leading-in conductors were sealed in the closing chamber of the lamp by fusing the glass upon the conductors and in which
1815 the glass chamber was sealed by the fusion of the glass?

A. Mr. Sawyer did have some of the bottoms fused to the globes of our lamps.

54 Q. State, if you recollect, when Mr. Sawyer did this, and how he did it?

A. In the fall of 1878, while we were at 94 Walker street, Mr. Sawyer got a glass blower, who had his place directly opposite to ours in Walker street, to fuse some of the bottoms on to the lamps, and fuse glass tubes
1816 into the bottoms. The interiors of the lamps were set up, and the glass tubes fused in with the conductors in the glass tubes before the bottoms were fused on to the globes. The bottoms were fused on to the globes after the interior part of the lamp was set up. Mr. Sawyer also had some of our lamps blown in which there were no bottoms separate from the globe, but the conductors were led through the glass of the globes

1817

and fused in them, the works of the lamp being set up inside it, before this operation was performed.

52 Q. As I understand you, Mr. Sawyer, in making these lamps, first made the leading-in conductors, and fixed upon them the illuminating conductor, or incandescent portion, and then after inserting these parts into the globe of the lamp, fused the glass around the leading-in wires, and then fused the tube into the globe for filling and exhausting?

A. Yes, sir, that is right. That was the way with some of them, but in some of them, he first fused the 1818
conductors through the bottom, which was a separate piece of glass, and then fused the bottom to the globe.

53 Q. In that way, as I understand you, an all-glass lamp having its several glass parts fused together was obtained?

A. Yes.

54 Q. And the leading-in wires used in the glass?

A. Yes.

55 Q. How many of such lamps were made or caused to be made? 1819

A. I do not know. Only a few.

56 Q. Were any of them put in operation?

A. Yes, sir; some of them were in the shop at 94 Walker street.

57 Q. State, if you know, the name of the glass blower who made these lamps?

A. I do not know.

58 Q. Were those lamps made in the latter part of 1878, or in the beginning of 1879?

A. They were made in the fall of 1878, before Mr. 1820
Lawrence Meyers came to the shop to stay.

59 Q. Do you know what became of those lamps?

A. I do not; I think Mr. Sawyer took them.

60 Q. In the manufacture of your lamps, was it your practice to grind the bottom of the lamp upon, or to the bottom of the globe of the lamp?

1821

A. The bottom and flange of the globe were first ground accurately true upon a lap or face plate. They were then ground together until they were accurately fitted so as to be positively air-tight, and to preserve a vacuum within the lamp without anything further, without any cement, or anything of the kind.

61 Q. Why did you prefer to make your lamps in that way rather than to fuse the bottom to the lamp?

A. We preferred to make them in that way, for the
1822 reason that we could take them down and put them up as often as we pleased, and restore the incandescent portion of the lamp without injury to the rest of the lamp.

62 Q. Was it common knowledge with you and Mr. Sawyer, that is, was it a thing well known to you both at the time you were making these lamps, that the bottoms of the lamps could be fused to the globe as well as *ground* to the bottom of the enclosing chamber?

A. We not only knew that the bottoms could be
1823 fused on to the lamps, and the conductors fused through the walls of the globe or its bottom, but we had had such experience in regard to the matter ourselves, in having the globe of the lamp itself, which was broken, mended, by putting the piece back and fusing it in by the glass blower. Further than this, we both knew of the common use of Geissler tubes in which the conductors were led through and fused into the walls of a glass chamber in which a vacuum existed or was produced. One of the lamps referred to in my testimony
1824 in the Interference case with Edison as to his patent, was broken. It was an exhibit in this case. I took it to Mr. Hahn with the piece that had been broken out of it, and he fused the piece in again, restoring the globe of the lamp. This was while we were at 43 Centre street.

63 Q. Do you wish me to understand that the idea of making the enclosing chamber of the lamp wholly of

glass, and having its several parts fused together, was 1825
a thing well known to both Mr. Sawyer and yourself, but that you preferred to make your enclosing chamber wholly of glass, having its two parts ground together, instead of fused together, for the convenience of taking the lamp apart and renewing the carbons, or any other part of it in the enclosing chamber?

A. I do; that is exactly what I mean. The fusing of glass together was old and well known, and the fusing of conductors through glass was old and well 1826
known. Sawyer and I frequently discussed the subject-matter of fusing instead of grinding and fitting the parts together.

64 Q. Is it true, as a matter of fact, that it was well known to both you and Mr. Sawyer that it was a common thing to make glass enclosing chambers wholly of glass, having their several parts either fused or ground together, as might be considered most expedient?

A. Yes, sir; it was known in this way. We, both of us, knew of the ordinary receivers of air pumps in 1827
which the vacuum is produced, and in which the bottom being of glass, the bell jar was ground and fitted to it; and our method of making the lamp was a mere matter of preference. We both knew of the fusing of the several parts of a glass vessel together, and of the fitting of them together, and we adopted as our ordinary peactice the fitting of them together in preference to fusing them together for the reason I have stated.

65 Q. Please to state exactly what your usual practice was in sealing your lamps so as to maintain a 1828
vacuum in the enclosing chamber, or an atmosphere of attenuated inert gas?

A. As I have said, we accurately fitted the parts together, so that a vacuum would be pretty well maintained in the lamp with nothing further done. We then placed Canada balsam, the exudation from the blisters of the balsam fir tree, upon the glass, very

1829 slight in amount, and rubbed the glass parts together with the balsam between them, until they were perfectly transparent, in the same manner as acromatic telescope lenses are made. We then firmly clamped the pieces together and covered the junction with melted wax, or other substance, to exclude all air from it. We then inserted the whole base of the lamp in a cup of melted wax and allowed it to cool so as to exclude all possible air getting at the base of the lamp.

66 Q. By this method of sealing, did you, as an
1830 actual fact, get an enclosing chamber in which you could maintain a high vacuum?

A. We did.

67 Q. For an indefinite period of time?

A. Yes; so much so that when we took our lamps down it was difficult to separate the parts.

68 Q. In the use of your lamps, made as you have described, did you experience any difficulty in the sealing of the lamp from the heat generated by the incandescent burner?

1831 A. We did not.

69 Q. How long did you succeed in getting your lamps to burn continuously or periodically in 1878?

A. For hours, days and weeks; I have testified fully in regard to that matter in the Interference case between ourselves and Mr. Edison about this invention, and I have nothing further to add to that testimony; it is correct to the best of my recollection, and I make my testimony on that subject in that Interference, my answer to your qestion.

1832 70 Q. In your last answer you have referred to an Interference between yourselves and Mr. Edison, I place in your hands a certified copy of the testimony on behalf of Sawyer and Man in that case; please to take it and state between what pages of that record your testimony is to be found?

A. In the original case my testimony is to be found

on pages two to twenty-five, both inclusive, and also 1833
on pages 101 to 106 both inclusive of the same record. In the supplemental record, my testimony is to be found on pages thirty-five to sixty-three both inclusive.

71 Q. State whether you have recently read that testimony, and if so, whether you find it correct and true, and whether or not you desire to make any additions to, or alterations of that testimony?

A. It is correct and true to the best of my recollection, except in one particular. On page twelve of the 1834
original record, in answer to cross-question 42, it appears by the record that I stated, "we moved there (meaning 43 Centre street) on the 6th or 7th of February; of that there is no doubt." The word February is either a mistake of the printer or a *lapsus linguae* of mine. It should be changed to March, so as to read, "we moved there (meaning to 43 Centre street) on the 6th or 7th of March, 1878; of that there can be no doubt." I then had in my possession a letter from Mr. Sawyer, of the same date as the day we moved to Cen- 1835
tre street, referring to the securing of that place, and requesting me to come there, which enables me to positively fix the date. I have read the testimony recently, and I should testify to the same effect to-day if called upon to do so, as I testified then, according to the best of my recollection.

72 Q. Referring now to your testimony as given in the Interference, is that testimony, in so far as it bears upon the date of the making of the incandescent conductor of carbonized paper, applicable and pertinent to 1836
the date of the making of such conductors, of other fibrous or textile material about which you have testified?

A. It is. The work was done as one whole, and at about the same time in the Spring of 1878 and was continued in the Fall and Winter following.

73 Q. What was the decision of the Commissioner of Patents in the Interference?

1837 A. The Commissioner awarded priority of invention to Sawyer and Man

74 Q. Please to produce, if you can, a certified copy of the Commissioner's decision in that Interference?

A. I now do so.

Copy offered in evidence, and marked "Complainant's Exhibit No. 30."

75 Q. Were you acquainted with William Sawyer,
1838 one of the witnesses who testified in the Interference?

A. I was.

76 Q. State, if you know, where he is?

A. He is dead. He was the father of William E. Sawyer.

77 Q. And the father and son are both now dead?

A. The Father and son are both now dead.

Adjourned to Monday, April 18, 1887, at 1 o'clock P. M.

1839

New York, April 18, 1887.

APPEARANCES:

Messrs. Broadnax & Bull for the complainant.

Messrs. Tomlinson & Dyer for the defendants.

Parties met pursuant to adjournment.

Albon Man.

1840

Examination continued by Mr. Broadnax:

78 Q. Referring to the invention claimed by the patent in suit, what advantage was obtained in incandescent electric lighting by such improvements?

A. By the invention of the patent in suit we obtained a pure homogenous carbon burner of exactly the length, form and size we wanted it, a burner that had also the

necessary tenacity and density, and one in which the 1841
electrical resistance necessary to insure success could be exactly regulated; the production of an illuminating conductor for an incandescent electric lamp having these properties all united in it was a great improvement in electric lighting, as by it, it became possible, taken in connection with other improvements made by us, to make an incandescent electric lamp that was practically permanent; a lamp that cast no shadows,
and in which the burner could expand and contract 1842
without injury to itself or the lamp.

An illuminating conductor having the properties I have pointed out was a new article at the time we made the invention, and it forms the essential feature of the patent in suit and makes an element in each and all the claims, and upon this element all the claims of the patent depend for their novelty; and upon a carbon burner having these properties depends the practical success of the incandescent electric lamp of to-day.

79 Q. To what degree of perfection did you and Mr. 1843
Sawyer reduce this invention in the Spring of 1878?

A. We made a thoroughly operative incandescent electric lamp, having a carbon burner possessing the properties I have specified; and we made a number of such lamps in the Fall of 1878 and the Winter following; and we also made arrangement to have such lamps manufactured at once upon a commercial scale. The manufacture and introduction of our invention, however, was not carried out until later on by other parties, but not because the lamp as made by us in 1878 was not
practical or operative. The failure to manufacture and 1844
introduce our invention at the time or immediately after it was first made was due to causes wholly outside of the invention or the lamp in which it was embodied; I do not mean that we did not afterwards make a better lamp by availing ourselves of better workmanship and by perfection of details already embodied in the lamp,

1845 but the lamp embodying these inventions which we made in the Spring of 1878 was a thoroughly operative lamp.

80 Q. I place in your hands Complainant's Exhibit No. 21, being Edison's incandescent electric lamp, and I also place in your hand the admission of Complainant's Counsel as to the manner in which that lamp is made. Please state whether or not, as a matter of fact, that lamp made upon the plan described in that admission embraces and includes an incandescent conductor for
1846 an electric lamp of carbonized fibrous or textile material, and of an arch or horse-shoe shape?

A. It does.

81 Q. Please to state whether or not that lamp embraces and includes the combination substantially of an electric circuit and an incandescent conductor of carbonized fibrous material included in and forming part of said circuit, and a transparent hermetically sealed chamber in which the conductor is enclosed?

1847 A. When put into use it does.

82 Q. Please state whether or not that lamp embraces and includes an incandescent electric lamp composed of the following elements in combination: first, an illuminating chamber made wholly of glass, hermetically sealed, and out of which all carbon consuming gases have been exhausted or driven; second, an electric circuit conductor passing through the glass walls of said chamber and hermetically sealed therein; third, an illuminating conductor in said circuit and forming part thereof within said chamber, consisting of
1848 carbon made from a fibrous or textile material, and having the form of an arch or loop?

A. I cannot know from the appearance of the lamp that the air has been exhausted from it sufficiently or completely, or that it is filled with gas inert to carbon at high incandescence. But taking the defendant's admission as the fact in regard to these things, together

with the fact that it would not be an operative electric 1849
lamp unless the air were properly exhausted, or it were filled with proper gases replacing the air, and taking his admission as to the character of the carbon contained therein, I answer it does.

83 Q. In the manufacture of the incandescent conductors for your electric lamps as you have described, did you, as a matter of fact, cut your blanks for carbons to size and shape before carbonizing them, in the year of 1878 and subsequently?

A. We did, ordinarily. 1850

84 Q. Why did you do that?

A. Because, first, the material before carbonization was more easily worked than afterwards. Second, we selected paper, because it was already reduced to size in one dimension, and its fibres were nearly all in one plane. We cut the wood and other vegetable material so as to have the fibres run in the direction of length of the conductor, as far as practicable, and to reject an imperfect portion of the wood or paper, and, so far as other fibrous material was concerned, to get that 1851
which would be perfect after carbonization. It was impossible to make such selection as to quality of material or disposition of the fibres if the material were carbonized in mass. Third, because by these means we were able to get a pure carbon by the use of these materials cut to shape, without flaws or cracks, with which we were troubled in endeavoring to carbonize in mass, and afterwards to reduce to size and shape; and also because the carbonization of the small incandescent conductors was more perfect and uniform where they were cut to 1852
size and shape before carbonization than could be made from substances in mass.

And besides that, it was a very difficult and painstaking work to reduce the carbons to uniform size and of proper tenuity after carbonization. We succeeded in doing it, but our failures were many compared with

1853 one success. And even when we succeeded the conductors were deficient in uniformity and homogeniety. We decided that it was too expensive and unsatisfactory to work them down after carbonization.

85 Q. What success did you meet with in making these fibrous carbons from willow twigs split up and the pith and bark removed, as you have stated, and bent to shape?

A. We made and used them a good deal, and they
1854 made very good lamps. The same is true of the excelsior.

86 Q. How did the large carbons differ, if at all from the small carbon made of the same material?

A. They differed in size, length and resistance, as I have said. They did not differ in their properties as carbon incandescent conductors.

87 Q. You say you experienced no difficulty in the sealing of your lamp from the heat generated by the lamp; why then did you use the soapstone disc just
1855 below the incandescent conductor?

A. We used the soapstone disc in our lamps as a mere matter of precaution. At first our lamps did not last as well as we wanted them to. We did not know to what particular cause, of many possible causes, to attribute this to. We suspected one might be the radiation of heat to the part where the lamp was sealed, by which the sealing might be rendered imperfect, thus admitting air to the chamber of the lamp. To avoid this heat radiation we introduced the soapstone disc
1856 and the spirally-formed conductor, by which means we averted the heating of the base of the lamp, which was objectionable not only as regards the sealing of the lamp, but also the handling of it. We though it a good device and patented it. We subsequently ascertained that it was not necessary, and ultimately left it out.

88 Q. In answer to question twelve you say that in some cases you stuck several thicknesses of paper together before carbonization, why did you do that? 1857

A. When we wanted a thick carbon we stuck together several thickness of the paper. When we wanted a thin or fine carbon we made it of a single thickness, or a less number of sheets stuck together.

ALBON MAN.

Direct examination closed

Subscribed and sworn to before me this 27th day of June, 1887. 1858

JOHN A. SHIELDS,

Examiner, etc.

Upon the conclusion of the foregoing examination-in-chief, defendant's counsel enters the following objections to the question mentioned in each objection, and it is consented that said objections shall have the same force and effect as if made upon the conclusion of each of said questions.

7 Q. Objected to as calling for a conclusion 1859
and it is insisted that the witness must state what was done by him and Sawyer which it is asserted constitutes the making of the invention and witness must state what the invention so alleged to be made is.

8 Q. Objected to as calling for a conclusion and it is insisted that the witness must state the facts which it is claimed constitutes a reduction to practice. 1860

9 Q. Objected to upon the grounds that the question assumes that the invention was reduced to practice and does not call for any fact or facts which show such a reduction to practice; and further that the question calls for a conclusion of the witness as to what was "used," whereas inquiry should be made as to the facts alleged to constitute a use.

1862 10 Q. Objected to as calling for a conclusion,
and defendant's counsel insist that it is en-
tirely improper to ask the witness as to the
kinds of wood used, but must ask the witness
concerning the facts upon which the alleged
use is based.

16 Q. Objected to as irrelevant and imma-
terial.

17 Q. Objected to as calling for a conclusion,
and not as to any facts.

1862 19 Q. Objected to as irrelevant and imma-
terial.

21 Q. Same objection, and as calling for a
conclusion.

22 Q. Objected to as irrelevant and imma-
terial.

23 Q. Objected to as calling for a conclusion,
and defendant's counsel insist that the wit-
ness must be asked concerning the facts
alleged to constitute the making of the in-
1863 vention; and further, that witness must be
compelled to define what the invention of the
second claim is.

24 Q. Same objection.

25 Q. Same objection.

27 Q. Objected to as irrelevant and imma-
terial.

28 Q. Same objection, and as calling for a
conclusion.

39 Q. Objected to as incompetent, and
1864 that the papers must speak for themselves.

42 Q. Objected to as calling for a con-
clusion and not asking for any facts.

44 Q. Same objection.

49 Q. Objected to as incompetent, irrele-
vant and immaterial.

50 Q. Same objection.

51 Q. Same objection.

52 Q. Same objection. 1865

53 Q. Same objection.

54 Q. Same objection.

55 Q. Same objection.

56 Q. Same objection, and as calling for a
conclusion.

62 Q. Same objected as to Q. 49.

63 Q. Objected to as calling for a conclu-
sion, and as incompetent, irrelevant and im-
material. 1866

64 Q. Same objection.

66 Q. Objected to as calling for a conclu-
sion.

67 Q. Same objection.

68 Q. Same objection.

69 Q. Objected to as incompetent, irrele-
vant and immaterial, and as not calling for
any testimony concerning lamps in which the
invention of the patent in suit was employed.

71 Q. Objected to as incompetent, irrele- 1867
vant and immaterial, and further, that the
testimony in the interference referred to can-
not be made a part of the testimony-in-chief
in this case by reference and general corrob-
oration.

72 Q. Objected to as calling for a conclu-
sion and not as to any facts, and as entirely
incompetent, irrelevant and immaterial, and
upon the further grounds stated in objection
to Q. 71. 1868

78 Q. Objected to as incompetent, irrele-
vant and immaterial, and as calling for a con-
clusion, and further, as not defining what the
invention in suit is.

79 Q. Same objection.

80 Q. Objected to as incompetent, and as
calling for a conclusion and not for any facts.

1869 81 Q. Same objection.

82 Q. Same objection.

83 Q. Objected to as incompetent, irrelevant and immaterial.

84 Q. Same objection.

85 Q. Objected to as calling for a conclusion and not for any facts.

1870 ———

296 x-Q. Were you aware at the time of the Herald article of December 21st, 1879?

Same objection and notice.

A. I believe I was.

297 x-Q. Were you aware of the article published in Scribner's Monthly for February, 1880, ar the time
1871 of its publication?

Same objection and notice.

A. I do not remember, but I think it probable.

Defendants' counsel offers in evidence a copy of the N. Y. Herald, of December 21, 1879, containing an article on Mr. Edison's electric light invention, and the same is marked "Defendants' Exhibit Herald article
1872 of December 21, 1879, July 8, 1887."

Defendants' counsel also offers in evidence Scribner's Monthly for February, 1880, and the same is marked "Defendants' Exhibit, Scribner's Monthly, July 8, 1887."

Exhibits objected to as irrelevant, incompetent, immaterial, and not proper cross-examination, and not proved as having been published.

1873

298 x-Q. Were you aware at the time, or did you read at the time, the publication in the New York Sun of December 22, 1879, of the article entitled "Electrician Sawyer's Challenge to Electrician Edison"?

Same objection and notice as to last question.

A. I think that I was, Mr. Sawyer, I think, calling attention to it soon after its publication.

299 x-Q. Did you read at the time, or were you
aware of the publication in the Sun of January 5, 1880, 1874
of the article entitled "Mr. Edison Challenged by Mr. Sawyer"?

Same objection and notice.

A. I do not remember now.

300 x-Q. Did you read at the time, or were you aware of Mr. Sawyer's letter to the Herald, headed "Sawyer on Edison and the Herald," and published in the Herald on December 24, 1879?

Same objection and notice. 1875

A. My attention was called to that article.

301 x-Q. Were you aware at the time, or did you read Mr. Sawyer's letter to the Herald of January 5, 1880, headed "78 Walker street"?

Same objection and notice.

A. I don't know; I don't recollect.

302 x-Q. Did you read Mr. Sawyer's letter, or were 1876
you aware of the publication of such letter, addressed to the Editor of the Herald, January 6, 1880, and entitled "Mr. Sawyer's Exhibitorium"?

Same objection and notice.

A. I don't recollect.

303 x-Q. Were you aware at the time of its publi-

1877

cation, or did you read Sawyer's book on electric lighting?

Same objection and notice.

A. I saw the book some time after its publication. I glanced at the book but never read it, to the best of my recollection.

304 x-Q. Did you, prior to the application for the
1878 patent in suit, have any conversation with Mr. Sawyer regarding these publications, or any of them?

Same objection and notice.

A. My impression is that I did, in regard to the first one mentioned, that of the Sun of December 22, 1879, or of the one in the Herald of December 24th, or both of them. I don't recollect any conversation in regard to the others.

305 x-Q. These two articles that you remember con-
1879 versing with Mr. Sawyer about, had you read at the time of the conversation?

Same objection and notice.

A. I think so, perhaps not at the first allusion to them. It may have been part of the same conversation.

306 x-Q. Did Mr. Sawyer, in these conversations, give you to understand that the letters thus published had been written by him?

1880

Same objection and notice.

A. I think Mr. Sawyer asked me if I had seen the paper. My impression of the conversation is that I learned from him that he had caused their publication.

307 x-Q. After the formation of the Electro Dynamic Light Co. on July 11, 1878, did that company have ample means at its disposal to apply for and obtain

patents for such inventions as you thought of value? 1881

Same objection and notice.

A. I think it did; certainly by the 1st of September or October following it had.

308 x-Q. Had Sawyer and Man jointly ample means with which to apply for patents on inventions regarded by them as valuable, prior to the formation of the company?

Same objection and notice. 1882

A. I had. Mr. Sawyer had not.

309 x-Q. During your connection with Sawyer, up to the first part of 1879, what were your habits with reference to applying for patents, separately, or you and he jointly?

Same objection and notice.

A. Some were applied for in our joint names, some 1883
in the name of Sawyer alone, and I think some, perhaps only one, in my own name, according to the advice of counsel, and in the manner of invention whether joint or separate, I don't recollect?

310 x-Q. Were you diligent in applying for your patents on such inventions as were made?

Same objection and notice.

A. I don't think we were.

311 x-Q. Had you not ample means of obtaining
such patents as you desired to apply for? 1884

Same objection and notice.

A. No, not at first. Mr. Sawyer was to pay for taking out the patents, and had not much means, and was very economical in his expenditure for patents.

312 x-Q. After your association with Mr. Sawyer, were not you and he amply able to pay for taking out

1885 such patents as you thought necessary?

Same objection and notice.

A. I was able to pay for any patent that I wanted to take out; Mr. Sawyer was not.

313 x-Q. How about Sawyer and Man jointly?

Same objection and notice.

A. As to Sawyer and Man jointly, we promptly ap-
1886 plied for what we considered the main patents. A fixed sum was agreed upon to be paid to Mr. Sawyer, out of which he was to pay for the patents. He was poor, and objected to taking out many patents, and said that after the company was organized all the patents that we needed, could be taken out, and they were. I could have personally paid for patents at any time, but I did not feel inclined to do so under these circumstances other than we did.

314 x-Q. Am I correct in understanding that upon
1887 making inventions which you considered of controlling importance, you promptly applied for patents for the same?

Same objection and notice.

A. Our first applications for patents were made from the 10th to the 15th of May, 1878, as I recollect, and from that time forward until some time in June we made application for what we then thought the most important things that we had invented from the time
1888 we went to work together in February previous, but we knew we were not applying for all, and our judgment as to what were the most important things, in the light of subsequent events, might not be deemed very good.

315 x-Q. After the formation of the Electro Dynamic Light Co., was that company to pay for the taking out of patents?

Same objection and notice.

A. Yes, sir; such as were taken out after its formation? 1889

316 x-Q. Did Sawyer's objection to taking out patents on inventions that were considered of minor importance by reason of his poverty, apply to that company?

Same objection and notice.

A. No, I don't think it applied to that company, that is, I don't mean that it was objecting to taking out 1890
patents.

317 x-Q. Am I correct in understanding that the company had ample means to patent such inventions as you or Mr. Sawyer thought desirable?

Same objection and notice.

A. Yes, as soon as arrangements for money were made, which was not until September or October, 1878.

318 x-Q. After that period were they not amply able 1891
to apply for and obtain such patents as were considered valuable?

Same objection and notice.

A. Yes, sir.

319 x-Q. When did you first meet William E. Sawyer?

A. Some time in January, 1878, at my house in Brooklyn.

320 x-Q. How did this meeting come about, and at 1892
whose introduction?

A. I think through Gen. E. L. Hayes, and perhaps William H. Church.

321 x-Q. State what led to your introduction to Mr. Sawyer, and with what object the introduction was brought about?

A. I had been talking to Mr. Hayes, my neighbor,

1893 about electricity, and especially the subject of electric lights; he had come to know Mr. Sawyer, or to know of him, as I understood, through Mr. Church. One, or both of them called upon me and obtained permission to bring Mr. Sawyer to see me; I think first, upon the plea that were mutually interested in the general subject of electricity, and that it would be interesting to know one another, and might be mutually advantageous.

1894 322 x-Q. Do you mean to be understood that your introduction to Mr. Sawyer was brought about solely by a desire to make personally acquainted two gentlemen interested in the general subject of electricity?

A. So far as I was concerned, yes; I have reason to believe that Mr. Sawyer hoped, by means of the introduction, to obtain financial assistance from me in carrying out some plans he had in mind.

323 x-Q. Please state what those plans were?

A. A plan, or plans for electric distribution, and
1895 some system of arc lighting; I do not think I ever got a definite idea of his exact plans in reference to arc lighting, but he had, before he came to see me, taken out a patent, or patents for electrical distribution.

324 x-Q. Was that his entire plan as you then understood it?

A. I do not recollect anything else.

325 x-Q. So far as Mr. Church or Mr. Hayes were concerned, were they at this time aware that Sawyer's object in meeting you was for the purpose of securing
1896 your financial assistance for perfecting or developing the plans referred to?

A. I don't know; I suppose so, or something like that, or that I might advise him or direct him to others, but Mr. Church knew that I would not interest myself in any way in the scheme he outlined to me of arc lighting, as I told him so.

326 x-Q. In the interview between yourself and Mr.

Sawyer, when he was presented to you by Mr. Church, 1897
did he explain to you any plans of his in which he desired your assistance, or did your conversation have on reference to business matters?

A. Mr. Sawyer brought with him some diagrams showing his plans of electric distribution and explained them to me, and also spoke of some ideas that he had in regard to electric lamps, and we talked upon that and general electrical subjects, during the course of which I said to him that I did not want to interest myself in 1898
the subject, especially in the then present condition of electric lights: the light of which he talked being the arc light; in the course of the conversation I had taken occasion to state that Mr. Church had told me that he (Sawyer) having heard of my interest in electrical subjects had hopes that I would interest myself or introduce him to others who would take interest in his projects; he in some measure or in some way assented to this, and said anyway whether I interested myself with him or not, he was glad to talk with me. The subject 1899
of incandescent electric lights was introduced by me, and I asked Mr. Sawyer what he knew in regard to the subject matter; he referred to the experiments he had made, and referred especially to those of Lodyguine and King and some others of whom I had heard; we discussed their attempts, and I expressed the opinion that that was the true method of electric lighting, and the only one suitable for interior illumination, and that arc lights were only fit for out of doors and large places; I think Mr. Sawyer at this interview, or at one im- 1900
mediately afterwards within a day or two, told me that he thought he could make an incandescent lamp or permanent lamp, as we called it, in which I had expressed great interest, and then told me he was going to try it. I certainly intimated to him that I might be willing to interest myself in a project of that kind financially, in connection with his system of distribution and other

1901 plans of which he had talked, and of which I talked with him.

327 x-Q. When, after the interview referred to in your 326th answer, did you next see Mr. Sawyer, and where?

A. We met almost every day after our first interview at my house; several times at my house, afterwards at my office in New York.

328 x-Q. What caused these interviews?

A. An appointment at each meeting for a subsequent
1902 meeting.

329 x-Q. Was Mr. Mr. Sawyer endeavoing to interest you financially in the development of his plans?

A. Yes; both that and to discuss plans with me—plans relating to electric lighting by incandescence.

330 x-Q. Did these plans relate to the invention of a lamp by Sawyer, or to the securing of financial aid for the conduct of experiments in that direction?

A. Mr. Sawyer wanted to make experiments; wanted my advice and assistance as to the apparatus for the
1903 experiments, and wanted that I should advance the money for the experiments and be interested in whatever should grow out of them; whether he came to me solely for the purpose of money considerations, after the first I culd not know, except that he did not so express himself, but was on the contrary continually asking advice and suggestions from me. I had suggested the matter of incandescent lighting at first, and he seemed very much taken with it.

331 x-Q. As I understand you and your first inter-
1904 view with Mr. Sawyer, he desired your financial assistance in developing his plans of distribution and electric lamps, which you understood to be arc lights, and that you refused your co-operation, stating that you did not believe in arc lights in the then condition of the art, but that you did believe in incandescent lamps of the type of those made by Lodyguine and

King, and that you would be willing to further any plan for the development of his system of distribution in the development of those lamps. Am I correct in so understanding you? 1905

A. I do not mean to be understood in the exact manner of your statement in the question.

332 x-Q In what respect is my statement incorrect?

A. I simply meant to say that I intimated to Mr. Sawyer that I did not want to be interested in his plans as he then presented them to me, and that they had reference to a system of distribution, and of arc 1906
lamps in which I had no confidence for purposes of interior illumination and general use in the then condition of the art. I did not command any type of lamp like Lodyguines or Kings, only intimated to Mr. Sawyer, after his saying that he thought he could make a permanent lamp, that I might possibly take an interest in such a thing.

333 x-Q. Is it, then, true that Sawyer stated to you that he thought he could make a permanent or incandescent lamp, anc that you intimated to him that you 1907
might aid him financially in the enterprise?

A. Substantially, yes, to some small extent, upon condition that I saw any probability of success in his experiments proposed, or to be proposed.

334 x-Q. Is it also true that, after this this interview, Mr. Sawyer was continually calling on you, endeavoring to secure your financial aid for the conduct of experiments on incandescent lamps?

A. Your question implies what is true, and what is not true. Mr. Sawyer was calling upon me to get my 1908
views of his projects with reference to the experiments of which he wanted and expected me to bear the expense. So far as this expense was concerned, he was seeking my financial aid; so far as he was seeking criticism, advice and suggestions from me, he was not. However, this continued but a short time, when, see-

1909 ing some prospect of success, I agreed to bear the expense of experiments, which were immediately commenced.

335 x-Q. When was the agreement made, and was it in writing?

A. I cannot give the exact date, and I do not recollect whether the matter was put in writing at first or shortly afterwards. It was put in writing about the time it was made.

1910 336 x-Q. Have you that agreement, or a copy?

A. I have neither the original nor a copy, and neither is within my control. The agreement as referred to is in my examination-in-chief; it is dated February 15, 1878, and is quoted in my examination-in-chief, in answer to question 32.

337 x-Q. At what place were experiments first performed relating to incandescent lamps, after the making of the agreement referred to?

A. My recollection is at No. 43 Centre street, New
1911 York City.

338 x-Q. Had any experiment been conducted prior to the experiments conducted at No. 43 Centre street?

A. Yes; I think one, and that may have been subsequent to the making of the agreement referred to. I am not positive.

339 x-Q. What was the experiment referred to? Where, and by whom was it performed?

A. At the Coal and Iron Exchange, corner Church
1912 and Cortlandt streets, New York City. The experiment consisted in heating up a piece of platinum, or a piece of carbon, I am not sure which, in a bottle filled with ordinary illuminating gas from the gas main, by means of an electric current, and was performed by Mr. Sawyer, assisted by myself. I think Mr. George Sawyer, his brother, was present part of the time, but I am not sure; if he were present, that was all.

340 x-Q. How did you come to be a witness of, or a participant in this experiment? 1913

A. By pre-arrangement with Mr. Sawyer.

341 x-Q. Please to state what was said by Mr. Sawyer, and fully, what led to your going to the place referred to, to witness or take part in this experiment?

A. I do not recollect the words of the conversation at this time, but only the substance of what took place; that was: in the absence of a laboratory we could not make any gas; we had no means exhaustion; no means 1914
of preserving a vacuum, or partial vacuum, if obtained; no dynamo for the production of electricity, and under the circumstances our thoughts reverted to the ordinary gas used for illumination, which, by its pressure, could be kept flowing through the vessel to the exclusion of the atmospheric air. Mr. Sawyer said that there was an old battery at his office which he thought we could rig up to get a current, so we drew diagrams of the holders of the cardon, and Mr. Sawyer's father, who was a machinist, made the holder and cap for the neck 1915
of the bottle. Mr. Sawyer himself rigged up the old battery, and when he had got it ready I went down to his place the same day, after office hours, and he and I tried the experiment.

341a x-Q. Do you mean to say that the subject matter of this experiment had been a matter of discussion between yourself and Mr. Sawyer?

A. I do.

342 x-Q. And that you and he had discussed the general character of the lamp which was made and tried? 1916

A. Yes, I do.

343 x-Q. Is it not the fact that you went to the Coal and Iron Exchange on the day mentioned rather to see a lamp which Mr. Sawyer had made, and wished to show you than take part in the experiment?

A. That is not a correct statement of my recollection

1917 of it. It is true, that when I went to the place I did not expect or intend to take any part in the experiment personally, but it is true also, that the whole matter was planned, discussed and talked over between Mr. Sawyer and myself before the experiment was made. It is also true that I considered the matter, as a whole, Mr. Sawyer's matter, and not mine, although I had advised and planned with him about it.

344 x-Q. When you went there, was the so-called lamp already put together and charged?

1918 A. No sir; nor was it there when I got there.

345 x-Q. Please state all that was done, so far as this so-called lamp was concerned, by yourself and Mr. Sawyer on the day and at the place referred to?

A. I think Mr. Sawyer's brother, George, came to my office and told me that his brother would like to have me call upon him, giving me his place in the Coal and Iron Exchange, after I got through with my business, according to some previous arrangement. At all events, I went, found Mr. Sawyer and his brother

1919 there; but none of the apparatus ready. Sawyer set his brother George to filling the battery, busied himself in hunting around for some of the apparatus, I forget what, perhaps some of the rubber tubing, or wire, that was to be used. I was in a hurry, and he sent George off somewhere to get the holders and cap. To hasten matters, I took hold and filled the battery. George was gone so long that Mr. Sawyer went down after him, and brought back the cap, with its holder, and a bottle. I think George did not return with him. The

1920 thing was crude and unfinished. There was no stopcocks; so we tied up the rubber tubing, connected to the inlets and outlet-tubes of the lamp, if it may be called a lamp. After allowing the gas to flow into and out of the bottle until the air was all driven out it was filled with gas. Then we turned on the current, and heated up the incandescent conductor between the holders, and

I think we repeated the operation twice or possibly three times, until we finally melted the junction between the incandescent portion and the holder, when the thing went out. 1921

346 x-Q. Please make a drawing of the so-called lamp to which you have referred?

A. I do.

347 x-Q. Where the globes of the shape shown by you.

A. I think it was a Florence flask about that shape. There was only one, and I think I got it for Mr. Sawyer. By that shape, I mean the shape of Florence flask. 1922

348 x-Q. What was the size and character of the incandescent conductor?

A. Its size, according to my recollection, was about one-sixteenth of an inch, possibly a little larger in diameter, or possibly less, and from five-eigths to three-fourths of an inch in length. My impression is that it was a broken, angular splinter of gas retort carbon. 1923

349 x-Q. What was the object of this experiment?

A. There were two objects. The first was to see an incandescent lamp, the next was to ascertain whether hydrogen gas would be a suitable substance with which to fill the lamp to prevent the consumption of its illuminating part, and at the same time be safe from explosion; the explosive property of hydro-carbon gas, which we used, being the same practically as pure hydrogen when either is mixed with air; we used the hydro-carbon gas; we could not get hydrogen conveniently. 1924

350 x-Q. Aside from the desire to see an incandescent lamp, am I correct in understanding that the sole object of this experiment was to ascertain if an explosion would occur when burning the conductor to incandescence in any atmosphere of hydrogen or hydro-carbon which contained atmospheric air?

A. Yes, in substance; that we wanted to know how

1925 carefully, and to what extent the air would have to be driven out by the hydrogen or hydro-carbon gas to prevent, first, the destruction of the carbon by burning, and second, explosion.

351 x-Q. How long did the conductor remain incandescent in the experiment referred to?

A. Not more than ten or fifteen minutes at a time, I should think.

352 x-Q. How many times was the conductor incandescent?

A. I cannot recollect; several times, and the thing
1926 was refilled more than once.

353 x-Q. Was the same carbon used each time?

A. No, sir. I think separate splinters of carbon were used.

354 x-Q. And the flask refilled each time new carbon was used?

A. Yes, sir.

355 x-Q. What was the occasion of changing the carbon, or refilling the flask?

1927 A. I think the carbon fell out of the holders.

356 x-Q. What time did you get to the office of Mr. Sawyer, and how long did you remain there on the day in question?

A. I cannot recollect with accuracy, but my impression would be that I got there between 4 and 5 o'clock, and left there between 7 and 8.

357 x-Q. Am I correct in understanding that the experiment to which you have referred was the only experiment performed prior to your going to Centre street?

1928 A. I have no recollection of taking part in any other experiment than that before going to Centre street.

358 x-Q. Did you witness any other, or learn of any other?

A. No, sir; I have no recollection of hearing or seeing any other experiment?

359 x-Q. Did you or Mr. Sawyer hire the room in

Centre street? Do you remember what rent was paid, 1929
and whether you paid rent from the time you took the room?

A. I do not recollect whether the arrangements were made by Sawyer or myself, or by both, for hiring the room, but think Sawyer looked it up and engaged it. I paid the rent; am under the impression that rent did not commence with the commencement of occupation, but only after some time elapsed. I do not recollect the rent was.

360 x-Q. What gives you the impression that your 1930
rent did not date from the time of occupancy?

A. The fact that at first we had no power, and had no machinery to run by power, and used a dynamo which was in the cellar below us, and which belonged to Arnoux & Hochausen, and over which he had no control, or its running. Also that arrangements for power and fitting up the room were made by the owner or his representative after we went there. I think our occupation at first was by favor to us from the owner 1931
or his agent or representative to allow us to avail our selves of the use of the dynamo, and in hopes that we would hire the room which was vacant.

361 x-Q. How soon after you went there did the payment of rent date from?

A. I can fix it with no certainty whatever. It may have been a week or ten days, and I think that most probable. Or it may have been only one or two days, or up to twenty or twenty-two days.

362 x-Q. Did you take a lease of the premises for 1932
any specific period?

A. I do not think we took a lease. We simply paid money and took a receipt for it, or simply paid it without a receipt, making a memoranda of it.

363 x-Q. Did you agree to take the room for any definite time?

A. I cannot recollect, but am under the impression

1933 that we paid for it month by month, for so long as we wanted it.

364 x-Q. Do you mean so far as any obligations on your part to the lessor were concerned, you could leave at the expiration of a month, or two months, or any period you saw fit?

A. Yes; and I think the landlord could compel us to leave at the expiration of any time for which we had paid.

1934 365 x-Q. Did you pay you rent by the month, or how?

A. I do not know, but am under the impression we paid oftener, and in advance.

366 x-Q. Is it your impression that if there was any occupancy without the payment of rent, it was merely for a few days prior to some well established rent day?

A. Yes, or to the usual day of payments by tenants, in that building, of which there was a large number.

367 x-Q. Have you any receipts or papers, checks
1935 or check-stubs, or memoranda, showing during what period rent was paid, and if so will you produce them at the next sitting?

A. I do not think I have any, but will look for them, and if I find any produce them.

368 x-Q. What arrangements for power and fitting up the room were made by the owner? Describe in detail what fitting up was done.

A. Some shafting and pulleys were put up, floors mended, windows fixed, doors closed off, work benches
1936 put up, partitions run, some, or nearly all of which was done by the owner, and some at our expense.

369 x-Q. Are you quite positive that their were no pulleys and shafting in the room when you first occupied it?

A. No. I am quite positive that there were pulleys and shafting in it, but additional pulleys were put up, and the same or other shafting was taken down, adjusted or rehung so that we could get poower from it.

370 x-Q. Did not arrangements exist in the room 1937
prior to your occupancy?

A. I think that the pulleys and shafts that were there were adjusted and in use for power in other parts of the building, and could only be used in this room by disconnecting the power elsewhere in whole or in part.

371 x-Q. If it be the case that you occupied the premises in question for any period without the payment of rent, is it your impression that you occupied
them merely so long as it may have taken to make the 1938
alterations or repairs referred to?

A. No, sir; but the fact that these things were being done, and were necessary before we or anybody else could make use of the premises, together with some dim recollection, makes me think that the rent did not commence to run for some time after we went there; but, as I said before, I am not positive in regard to this.

372 x-Q. When was the experiment in the Coal and 1939
Iron Exchange made, and when did you hire the room in 43 Centre Street?

A. It is my present recollection that the room in question was hired on the 7th day of March, 1878, but occupied by us on the 6th day of March, 1878, and I believe that the experiments to which I referred as taking place at the Coal and Iron Exchange, took place on the 6th or 7th day of February, 1878. I know it took place prior to the 15th day of February, 1878.

373 x-Q. When did you give up the rooms in Centre 1940
Street?

A. I forget whether in May or June, 1878. I should have to try and refresh my recollections in regard to it to be certain. This I will endeavor to do.

374 x-Q. Please describe with reference to the room you occupied in Centre Street, the basement in which was the machine owned by Arnoux and Hochausen, to which you have referred?

1941 A. As I recollect, our room was on the second floor on the northwest corner of the building. Arnoux & Hochausen's machine was in the basement underneath us, or cellar, I don't know which, with entrace from the court. The wires were run from the machine, on the outside walls of the court, and into a window of our room.

375 x-Q. By what power was the armature of the dynamo driven?

A. By a steam engine.

1942 376 x-Q. Do you mean by a separate steam engine that was placed there for that purpose, or by the ordinary engine in use in the building?

A. I do not think there was a separate engine put in for the purpose; the armature of the machine, when driven at all, was connected by a belt, pulleys and shafting driven by an engine in the building.

377 x-Q. Was this the machine used by you during your stay in Centre Street?

A. No, only at first. The first day or two, or three

1943 perhaps.

378 x-Q. What other dynamos, if any, did you have while there?

A. We had two or three of Arnoux & Hochausen make; one built especially for us, and the other, or others, loaned to us by them. A Weston machine or two; some other, possibly a Farmer-Wallace machine, or possibly some other manufacturers.

379 x-Q. Are you able to state definitely how many, and what machines, you had while at Centre Street?

1944 A. No.

380 x-Q. Why are you not able so to state?

A. Because we had a considerable number and variety of machines which we so tried.

381 x-Q. Are there no books, correspondence, papers, or memoranda of any kind, which would show just what machines you had, and where you obtained them?

A. I think not, except an agreement of Mr. William 1945
Hayes for the purchase of the one machine of Arnoux & Hochausen, which we bought. The other machines were loaned to us, or sent in on trial.

382 x-Q. Can you state what machines were used by you in Centre Street in your experiments, as distinguished from those you merely had on trial?

A. I should think that we principally used Arnoux & Hochausen machines.

383 x-Q. In the months of March, April, May and June, 1878, please state how many makers of dynamos 1946
there were from whom machines could have been procured?

A. I don't know.

384 x-Q. You have stated that the Arnoux & Hochausen machine which you first used was in the basement. Please state when it was that you first got a dynamo in your room in Centre Street, and from whom you got it?

A. My recollection is that about the time the machine in the basement was taken away, or perhaps be- 1947
fore then, we had agreed with Arnoux & Hochausen, or rather Mr. Wm. Hayes had for us agreed with them, to purchase a machine, and that in the meantime, and within a few days after we went to 43 Centre street, they loaned us a machine and kept on supplying us with a machine for most of the time up to the 25th of March, 1878, when the machine bought from them was delivered to us at 43 Centre street.

385 x-Q. What enables you to fix the 25th of March as the date of the delivery of the machine to you? 1948

A. I subsequently bought the machine and paid for it, and now have it, and the original bill for the purchase was endorsed over me, and I have it. I now produce this bill.

386 x-Q. Is this the bill of the first machine purchased for you in experiments in Centre street?

1949

A. It is.

> The same is offered in the evidence, and it is stipulated between counsel that a *fac simile* copy be marked in evidence, and that if either counsel request the original to be produced at the hearing the same will be produced by complainant's counsel, and the same is marked "Defendants' Exhibit Dynamo Bill."

1950 Counsel for complainant objects to the exhibit as not appertaining to anything brought out by the examination-in-chief, and as not pertinent or material to any of the issues of the case, nor as part of a legitimate cross-examination.

Witness adds: I desire to state that this machine may have been delivered prior to the 25th of March, 1878, but was certainly delivered as early as that date.

1951 387 x-Q. What enables you to fix that date as the day of delivery of the machine, or prior to which it was delivered?

A. The bill and my recollection after seeing the bill.

388 x-Q. Have you any memoranda by which you fix this date outside of the bill itself, or is there any circumstance which enables you to fix that date?

A. My recollection is that the machine was to be specially wound; that is, was delivered and tried. Mr.
1952 Hayes came to see it, perhaps immediately, perhaps after some days, and then gave a check to pay for it. I do not know of any other memoranda, and I don't recollect at this moment of any other circumstance.

389 x-Q. What is meant by the words "No. 1" in this bill?

A. I don't know, but suppose it to refer to the character of the machine.

390 x-Q. What is meant by the entry beginning with

"May 6th, '78," and ending with "Jacob Hays," at the 1953
bottom of the bill, and is that entry in your handwriting?

A. It means just what it says, and it is in my handwriting, except the signature, which was made by and is in the handwriting of Jacob Hayes.

391 x-Q. How did you come to purchase this machine from Mr. Hayes?

A. Mr. Hayes became one of the stockholders in the
organization of the Electric-Dynamic Light Co , and 1954
wanted me to take the machine and pay him for it, and then I think the same money was applied on his subscription for stock.

392 x-Q. Is it your present recollection that the light machine in the basement of the building was removed some two or three days after you went to Centre street?

It is; but speaking from recollection after nearly eight years, and the time may have been longer than
two or three days, or even a week. 1955

393 x-Q. Do you feel quite confident that it was not over a week?

A. I can only say that I think it was not, but it may have been, I am not extremely confident.

394 x-Q. I understand your recollection to be that you went to Centre street, the 6th or 7th of March; that the light machine referred to was in the basement at the time and remained there some two or three days, or possibly a week thereafter, and that the ma-
chine mentioned in the exhibit was delivered on the 1956
25th of March? From the time of the removal of the light machine to the delivery of the machine mentioned in the exhibit, what machine, if any did you have?

A. We borrowed from Arnoux & Hochausen one, two or three machines similar in form to the one we bought of them, but not specially wound for lighting. My recollection is within a day or two after we went

1957 into the building, and from that time up to the time when the machine we bought was delivered, and perhaps afterwards. It was one or more of these borrowed machines that we had for use during the period of which you inquire.

395 x-Q. And no other?

A. I don't recollect.

396 -Q. After receiving the machine mentioned in the exhibit, was any other machine used or tried by you in Centre street?

1958 A. Yes; similar Hochausen machines, also Weston, and I think Farmer & Wallace, but I cannot be certain now, whether the trials of the Weston, and Farmer & Wallace were before the 25th of March, 1878, or after, but I think they were after. We also probably tried another machine, but I don't recollect the makers' name.

397 x-Q. Was any other machine bought by, or for you while in Centre street?

A. I think not. We ordered another and different
1959 kind of Arnoux & Hochausen, but I think it was after we left Centre street.

398 x-Q. Can you not state just how many machines you had while in Centre street, either in use or on trial?

A. No, sir.

399 x-Q. Can you state what machines were used in contradistinction to those you tried but did not use?

A. Yes, mainly we used a large lighting machine
1960 which Arnoux & Hochausen had in the basement, the machine referred to in the bill "Defendants' Exhibit Dynamo Bill;" one or more machines similar to the last one mentioned made by Hochausen, but not specially wound; one or more Weston machines, but of these last we made little use.

400 x-Q. Were there machines other than the light

machines in the basement placed in your room in Centre street? 1961

A. Yes, sir.

401 x-Q. How were the armatures of these machines driven?

A. By steam power through shafting, pulleys and belting in the room connected by a belt to a pulley in another room.

402 x-Q. Am I correct in understanding that you had no separate engine, but depended on the power 1962 in the building, and that the armatures of the machines in your room were belted to pulleys in the building actuated by the steam power in the building?

A. Yes.

403 x-Q. Was any change made in the pulleys and shafting in the room after you went there?

A. Yes, sir.

404 x-Q. Please state what changes were made by you and Mr. Sawyer, or by the direction of either, in the pulleys or shafting?

A. I cannot recollect details, except that we bought 1963 one or more pulleys, and I think some shafting and hangers, countershaft and apparatus, fast and loose pulleys and beltings, and the engineer of the building, I think, put it up, assisted by Mr. Sawyer's father, who was employed by us.

405 x-Q. From whom were the articles mentioned purchased, by whom, and who paid for them?

A. I paid for them. I think they were selected by Mr. Sawyer's father and myself at several machinery 1964 places on Centre street and its vicinity.

406 x-Q. Can you not remember, or have you no means of ascertaining, at what places these purchases were made?

A. I cannot now remember, and don't know that I have any means of ascertaining.

407 x-Q. Did you keep any memoranda of expenses

1965 incurred by you while in Centre street, or no account of moneys expended?

A. Yes; I kept a memoranda of what I paid out at first as a loan, and after we had an agreement, I think March 19th, or thereabouts, as applying upon our agreement.

408 x-Q. Do you mean that you kept an account of moneys expended by you, showing when, for what, and to whom such moneys were paid?

1966 A. I think not generally, but only of the dates, amounts and what they were for.

409 x-Q. Would the purchase of the things referred to appear in such accounts?

A. The amounts paid by me for things would appear, I think, and I think that the things purchased, but not unfrequently these memorandums would be made by Mr. Sawyer, but my telling him what the things cost.

410 x-Q. How were the accounts kept, in a book?

1967 A. No. No regular accounts were kept. I had a little pass book in which I was in the habit of entering the amounts paid out, including money given to Mr. Sawyer, but many of the entries in this book covered one entry as expenditure on account of electric lighting, what I paid out for things, and money given to Mr. Sawyer. The object of the book was for my own information, in order that I might keep within the limit of the amount of money which I was to advance under my agreement with Mr. Sawyer?

1968 611 x-Q. What has become of that little book?

A. I don't know.

412 x-Q. When did you last see it?

A. It was used in the Edison Interference Case, and an extract from it appears in my testimony in that case, and I do not recollect to have seen the book since, and it was then in the hands of Mr. Amos Broadnax, counsel.

1969

413 x-Q. Were the shafting and pulleys mentioned by you put up, and if so, how long did it take to place them in position?

A. Yes, they were put up. I cannot recollect, not long, probably.

414 x-Q. About how long?

A. It was only a small amount of work and may have taken not more than a day or so.

415 x-Q. Please state as nearly as you now recollect, what were the shafting and pulleys and hangers in the room in Centre street when you went there, and what changes in them and additions to them did you make while there? 1970

A. I will give the best of my recollections, but cannot assume them to be accurate. There were one or more shafts in the room driven by the power in the building, on which were several pulleys of different sizes. We put on to one of these shafts an iron pulley of larger diameter than in the room. We also put up one or more pieces of shafting, supported by hangers parallel to the shafting that was in the room and having iron pulleys on it or them, some of which were fast and others loose; belting between the pulleys on the shaft and means of shifting from fast to loose pulleys, and reverse; belting from the pulleys of the shafts that we put up to the dynamos that we used. I think this was all that might be called machinery that we put up. It seems to me that we had a lathe or lathes which we had in motion by this machinery, but I am not certain. 1971

416 x-Q. What was the object of altering the pulleys and shafting, or adding to those as described in your answer? 1972

A. To give proper speed to dynamos, to enable us to place them where we wanted them in the room, and to start and stop them without interfering with any other machinery in the building.

1973 417 x-Q. Please state how much the alterations and additions made by you diminished or increased the speed you were able to attain.

A. I cannot.

418 x-Q. Can you not approximately?

A. No, sir.

419 x-Q. In making the alteration or additions referred to, were they made with reference to increasing or diminishing the speed which you could obtain directly from the pulleys and main shaft, when you went
1974 there?

A. I think they were made partly for obtaining increased speed in the movement of dynamo over what could be obtained by belting directly from the pulleys that were there when we went there, and partly to enable us to control the power and stop and start when we wanted to.

420 x-Q. Who was the engineer that you have mentioned that may have assisted Mr. Sawyer in making these alterations?

1975 A. I do not know as I ever knew his name.

421 x-Q. Was he the engineer of the building, or a person whom you regarded as such?

A. I think he was.

422 x-Q. What machinery, if any, other than pulleys and shafting and hangers referred to did you have in the room in Centre street? By machinery I do not include apparatus.

A. Dynamo machines, I think a lathe or two, and we may have other things, but I do not recollect.

1976 423 x-Q. What makes you now think that you had a lathe or two, when but a few minutes ago you could not remember whether you had or not?

A. I meant to express myself both times as in doubt, but at the same time to have expressed a possibility that we may have had them. I have no distinct recollection on the subject.

424 x-Q. Do you recollect any machinery other than lathes which you think you may have had at Centre street? 1977

A. I don't know.

425 x-Q. Please state what tools you had at Centre street.

A. We had a pretty good assortment of drills, files, chisels, dies, screw taps, hammers, saws, wrenches and other bench tools, with vices, laps, and I cannot recollect what all; also glass-cutters and glass-grinders, grindstones, whetstones, bits, bit stocks. I cannot 1978
recollect all.

426 x-Q. Where did you purchase or get the tools referred to in your last answer?

A. I do not recollect.

427 x-Q. Do you recollect whether they were, in fact, purchased?

A. I think some of them were and some of them were not.

428 x-Q. From whom were those that were purchased obtained, or who did the purchasing, and who 1979
paid the bills?

A. Can't recollect, except some things from Mr Frasse, then in Chatham street. He is a well-known tool man. I ultimately paid for everything.

429 x-Q. You have enumerated the machinery and tools which you had at Centre street. Please state what apparatus you had there?

A. We had a very great variety of apparatus, retorts, gas-holders, gas-bags, tubes and tubing in glass and metal, stop-cocks, oil and alcohol, and kerosene lamps. 1980
gas-heating apparatus, gas-generating apparatus, electrical apparatus, photometer, air pumps, one or more hand metallic, and one or more mercurial exhausting apparatus, operated on the principle of Geissler's pump. I do not know what else, but a great variety of things, among which was a great variety of utensils or appara-

1981

tus in glass, glass-mould, boxes for carbonizing, means of drying gases, de-oxidizing gases and purifying gases.

430 x-Q. Define what you described as a gas-heating and gas-generating apparatus?

A. Heating apparatus, operated instead of lamps by burning gas, and apparatus heated up by lamps or burning gas through which gases to be heated were passed. Charcoal furnaces, urged by bellows for heating apparatus. We had several of these heaters of dif-
1982 ferent forms and kinds. Of the gas generators, I remember we had several for producing hydrogen gas, several for producing nitrogen gas, several for producing carbonic acid gas, some for producing chlorine and several for producing cyanagen.

431 x-Q. Please to describe the "charcoal furnace" referred to in you last answer?

A. One kind was an ordinary furnace like a tinner's or roofer's furnace; another one like an ordinary household charcoal furnace; another one made long and di-
1983 vided into compartments, on which was supported tubing running lengthwise of the furnace to prevent the tubing from bending when highly heated, similar to like apparatus as sold by chemical apparatus dealers, but longer and larger; some others of the same kind but of less size. In enumerating these things I desire to be understood as mentioning those things which come to my mind without attempting to give an exhaustive list, which I do not think it would be possible for me, or anybody else to do, after this length of time, nearly,
1984 eight years.

432 x-Q. Please to describe what you refer to as a household furnace?

A. It is known as a pail furnace, and can be bought in every establishment for the sale of household articles, used to boil a tea-kettle or heat a flat-iron, or the like, open at the top with a grate inside, an air space under the grate made sometimes of earthware, and sometimes of sheet or cast iron.

1985

433 x-Q. Plese state the dimentions and material of the furnace on which tubing was supported?

A. Some eight or ten inches square in cross-section and from two to four feet long, made of sheet iron with a grate and ash plate under the grate, lined with fire brick, and with fire brick or iron partition for supporting the tubing which ran lengthwise of the furnace. In cross-section this fire box inside, after the bricks were in, would be from three to six inches square; the grate extended the whole length of the furnace, and fire could 1986
be built in any compartment, or in all of them; it was fitted with a perforated cover to put on or take off as we chose.

434 x-Q. Please to specify what electrical apparatus you had while in Centre street?

A. We had several ganvanic batteries; some standard resistances, galvanometers, electric lamps, dynamos, thermo-electric battery, ordinary electroscopes. I do not recollect anything else at present; we had electromagnets and electric coils, switches and cut-outs, regu- 1987
lator, two or three devises; I don't know what else.

435 x-Q. The electric lamps, switches, cut-outs and regulators mentioned in your last answer were not apparatus which you bought, or took to Centre street for the purpose of making experiments, but were made there by you in the course of your experiments. Am I correct?

A. Yes.

436 x-Q. Have you now enumerated all the apparatus which you now remember you had in Centre 1988
street, and are you quite sure that all things enumerated by you were had by you and Mr. Sawyer while in Centre street?

A. I am quite sure that all the things enumerated by me were had by Mr. Sawyer and myself while in Centre street; I have not enumerated all, or nearly all of them, but only such as comes to my recollection while testifying; of these I have enumerated all that

1989 seem to me important to mention, which come to my mind.

437 x-Q. From whom was the various apparatus you have mentioned procured?

A. I cannot recollect.

438 x-Q. Cannot you recollect where any of it was procured?

A. Yes; some of it I got from different glass factories over in Brooklyn; some from Mr. Hahn, a
1990 glass-blower in William street, on North William street, near Chatham; some of it was bought from Hagerty Bros., in Platt street; some of it was bought from different rubber stores; some of it from different tin and sheet-iron workers; I think one of these was John Borkel, in Elm street; some of it was bought from an apparatus store in Barclay street; I cannot recollect the name; there was a glass-worker in Chambers street that fixed some apparatus for us; I don't know his name: some of it was got from an apparatus store in
1991 Greenwich street; I don't know the name or location; a good deal of it we made ourselves, at 43 Centre street; a good deal I took from my own private apparatus at my house; some was made and fitted up by William Sharp, who was in what was then known as Hickory street, Brooklyn; some we borrowed from different people; the dynamos I have spoken of, some electrical apparatus was obtained from Mr. Chester; some from Mr. Benjamin; I am not quite certain, but think some was borrowed from the School of Mines.

1992 439 x-Q. In the aggregate, as near as you now remember, what did this apparatus cost?

A. I cannot recollect, but think probably from $2,500 to $4,000.

440 x-Q. Who provided the money?

A. I and my friends provided it.

441 x-Q. Did your friends intrust their money to

you, and did you pay for the apparatus, or did you pay for some and they for others? 1993

A. I cannot recollect whether the money all passed through my hands or not; my impression is that it did not.

442 x-Q. Is it then your impression that some of your friends purchased apparatus directly, which apparatus was used by you in Centre street?

A. No, sir; but that they furnished money to Mr. Sawyer, who purchased apparatus with it. 1994

443 x-Q. Were any books, accounts, or vouchers ever kept of the expenditures of this money?

A. I have already stated that there were not; but memorandum accounts were kept by Mr. Sawyer, handed to me from time to time, and I think that said memorandums were all handed to Mr. Broadnax in '79. I also had a little book there, that had an account of expenditures, of which I have before spoken of in this case?

444 x-Q. Was any of this 2,500 or $4,000 expended 1995 for apparatus, paid by check, and if so, by whose?

A. I don't know that any of it was; I never paid any by check, except checks to the order of Mr. Wm. E. Sawyer, which he usually immediately endorsed, and which I therefore either gave him money for, or sent to the bank and got money so that he could have cash to make payments, unless it be in the case of a dynamo machine from Hochausen, about which I have testified.

445 x-Q. You say that the apparatus bought cost 1996 from $2,500 to $4,000. How much, about, was expended for experiments whild you were in Centre Street, including rent, labor and everything, and exclusive of payments to Mr. Sawyer for his personal services or use?

A. I think my estimate of apparatus includes experiments; it was all experimental till near the last apparatus and all; but does not include wages for Mr.

1997 Sawyer's personal expenditures, and is but a guess. I have no means of verifying it that I know of at present.

446 x-Q. And of these expenditures you know of no letters, vouchers, or memoranda of any kind, which would show in detail for what and when they were made excepting the memoranda and book of which you have testified? Is this correct?

A. I do not, unless among the papers which I gave to Mr. Broadnax, there may have been, as I testified,
1998 receipts of tradesmen, and it seems to me that there were such papers, but they may have been all kept by Mr. Sawyer.

447 x-Q. Where did you get the hand metallic air pump or pumps mentioned?

A. Mr. Sawyer borrowed it from somebody.

448 x-Q. Did you have more than one?

A. I am not certain whether he had more than one, or the same one at several times.

449 x-Q. Do you know from whom it was bor-
1999 rowed?

A. I do not recollect from whom it was borrowed.

450 x-Q. Did you purchase any hand metallic air pump or own one when in Centre Street?

A. No, sir.

451 x-Q. Did you have one there continually, or did you borrow it at such times as you wanted to use it?

A. We only borrowed it, though I think it remained several days at a time, and only used it until we got
2000 the mercury exhaust rigged up.

452 x-Q. From whom did you get the one or more mercurial exhausting apparatus operated on the principle of Geissler's pump mentioned in your last answer?

A. We got the stop-cocks from Mr. Hahn in North William street, and some of the glass tubing: the rest of glass tubing, glass bulbs and tubular bottles I got

made in a glass factory in Williamsburgh, and we 2001
rigged up the apparatus ourselves. We got 60 odd pounds of mercury through Mr. Hagerty, of Platt Street.

453 x-Q. Were accounts kept with any of these people so that their books would show their dealings with you, or were all payments made in cash as the bills were incurred?

A. We kept no accounts with anybody, and paid cash for everything as we bought it.

454 x-Q. What was your working force at Centre 2002
Street?

A. William E. Sawyer and myself; Mr. Wm. Sawyer, his father, part of the time; Mr. Sharp there part of the time, and part of the time at his shop in Brooklyn. A Mr. Keating and his men, one or two of them part of the time only at his shop in New York. Geo. Sawyer, a boy who ran errands.

455 x Q. Were Sharp and Keating employed by you in Centre Street?

A. Sharp was, but Keating, who had a shop of his 2003
own, was not, unless temporarily.

456 x-Q. Where are Sharp and Keating now?

A. Mr Sharp works for Wallace. Mr. Keating I suppose to be dead. I have searched for him, and been unable to find him for some years past.

457 x-Q. I understand that you left Centre Street the latter part of May or the 1st of June. What was the occasion of your leaving?

A. The occasion of our leaving Centre Street was that 2004
we had got our lamp and other inventions perfected and did not desire to go further until we secured our patents, and desired to avoid expense, while we did not need a workshop or laboratory.

458 x-Q. Do you mean that your inventions were perfected, and that you were now ready to manufacture them?

A. Yes; many of them.

2005

459 x-Q. Am I correct in understanding that you devoted your energies to securing patents on your invention, and did not care to do any more work until they had been secured?

A. Yes; that and organization and planning, and did not care to do any other work requiring the use of a laboratory or workshop just then.

460 x-Q. What were your habits in regard to going to the laboratory in Centre street?

2006 A. I was there from early morning until 9 or 9.30, an hour or more at noon, and from 3.30 until dark. Frequently at other times in the day. This was my habit, and about the only exception was, when I was away hunting up things for use in the shop.

461 x-Q. How early in the morning would you get there?

A. I was usually there for about an hour—sometimes more—about 8 o'clock.

462 x-Q. During all this time were you attending to

2007 your professional business?

A. Yes, sir.

463 x-Q. Was not your professional business at this time a large one, and did it not involve the custody and management of large intrests?

A. Yes; sir.

464 x-Q. What were Mr. William E. Sawyer's habits?

A. So far as the attendance of the laboratory was concerned he was in the habit of being there all day.

2008 465 x-Q. Was he abdicted to intemperance at this time?

A. I never saw him the worse for liquor while we were at Centre street.

466 x-Q. What were Mr. William Sawyer's habits as to attendance at the laboratory?

A. He was there during the usual work hours of mechanics, except when working at some other shops for us.

2009

467 x-Q. Please answer the same question with reference to Messrs. Sharp and Keating?

A. They were working mostly at their own shops.

468 x-Q. Did you neglect your other business to attend to experiments at Centre street, or were you attending to it regularly?

A. I was attending to my other business regularly during my ordinary office hours, except when I went out at noon, which I was not in the habit of doing. My ordinary business hours were from 9 to 3.30. 2010

469 x-Q. Was Sawyer and his father in the habit of getting to the laboratory as early as 8 o'clock in the morning?

A. Yes; they were usually there when I got there, except when the father was going elsewhere.

470 x-Q. To get to the laboratory at 8 you would have to leave your house at 7, would you not? Was it your habit of leaving at that hour?

A. Yes, sir; from 7 to a quarter past; and the time from my house to 43 Centre street, was usually about 2011
50 minutes.

471 x-Q. Do you think you were there every day during the time the laboratory was there?

A. I think I was, but my not have been during the first few days of April, as those days were very busy days at my office; nor during the first few days of May, for a like reason. I have no positive recollection except as to general habit.

472 x-Q. Was Mr. William E. Sawyer there every day?

A. I think he was at the place every day—some part 2012
of every day—except during the latter part of the period, when we were there; he was, however, frequently at my office during the time that I was at leisure to give attention to the matters we were at work on.

473 x-Q. Then in point of fact, William E. Sawyer was not there every day, and all day?

2013 A. Well, those words would give a correct impression of his attendance at the place 43 Centre street, his absences being exceptional occurrences made mostly for my convenience.

474 x-Q. Was he dissipated at this period?

A. At this time I had no knowledge of Mr. Sawyer's being an intemperate man or addicted to drink or other excesses; but from events which subsequently came to my knowledge, I had reason to think and believe afterwards, that he had been and was a dissipated man
2014 at this time, but under much self-restraint.

475 x-Q. Was not his father also a dissipated man and addicted to drink at this period?

A. My reply is the same as to the last question.

476 x-Q. In the Sawyer-Man Edison interference the following question was asked and answer made by Mr. Sawyer.

"Q. State as near as you can recollect, about how long you and Mr. Man continued your experiments at 43 Centre street? A. I should think about
2015 two months, all the time we were there?"

477 x-Q. Does your recollection agree with Mr. Sawyer's as to this?

A. Yes, substantially; it may, however, been longer than two months, and my impressions are that it was, but without refreshing my recollection I cannot speak with accuracy.

478 x-Q. In the same interference, the following question was asked Mr. Sawyer, and answer made by him:

2016 "After you got through there did you resume your "experiments at any other place? A. We moved from "there to No. 2 Howard street; where I don't think "we made any experiments on lamps, not having any "facilities for such experiments; we then moved in "the fall of the year to 94 Walker street; I have got

"memoranda to show of these things; we moved to 2017
"94 Walker street during the 18th and 19th of October, 1878."

479 x-Q. Do you agree with Mr. Sawyer as to his statement in the answer quoted, and is it a fact that you moved to Walker street about the 18th or 19th of October, 1878?

A. I do not; my recollection is different, and I think that the word "October" is a mistake, and should be September; but I speak from recollection, and 2018
there are papers which will show the date when we went to Walker street. As to the work done while we were at the corner of Howard and Centre streets, my recollection does not agree with Mr. Sawyer's. We made a lot of experiments at the corner of Howard and Centre streets, and had as assistants Mr. Frank Holbrook and Mr. Edward Myers; we also had Messrs. Arnoux & Hochausen, who were above us, doing a lot of work for us.

480 x-Q. I now call your attention to the following 2019
parts of your answer to the 17th question submitted to you in the same interference, and given in March, 1881: "I had been speaking thus far of only what "took place up to the 1st of June or last of May, "1878. We had no convenience from working from "that time up to September, and our experiments "were renewed in September, and continued on until "late in March, 1879." Is it true, as there stated by you, that you had no convenience for working from the last of May, 1878, and that your experiments were 2020
only renewed in September?

A. It is true that from the time we left Centre street until we went to work at the corner of Howard and Centre streets we had no shop, and that our experimental work as experiments was discontinued; during this period, however, we were engaged in the discussion of plans, designs, calculations, etc., and in ordering

2021 material and in getting apparatus for manufacture, and in getting manufacturing done, though not as actively as after we went to work at the corner of Howard and Centre streets; this period was from the last of May or 1st of June until the last of August or 1st of September; but we were not engaged in experimental work, though upon reflection and refreshing my recollection, our room at Howard and Centre street was hired perhaps as early as July. Mr. Sawyer went on his summer vacation, and afterwards I went on my vacation, and we did not resume experimental work un-
2022 til my return, about the 1st of September.

481 x-Q. As I understand you, you did no experimental work from the time of leaving 43 Centre street until Sepember 1st, 1878. Is this correct?

A. That is my recollection—that is to say, I do not recollect anything we did during this period.

482 x-Q. Where was it that experimental work was resumed?

A. At No. 2 Howard street.

2023 483 x-Q. How long after September 1st were you at Howard street?

A. My recollection is until the last part of September; I can fix the date exactly, I think.

484 x-Q. How many rooms did you have at Howard street, and what were their sizes?

A. Only one; about 12x20, with shop facilities in another room about 25x40 or 50, occupied mainly by Arnoux & Hochausen.

485 x-Q. What tools, apparatus, or machinery did
2024 you have in this Howard street room?

A. The same that we had in Centre street, or part of it; part, I think, being left in 43 Centre street, until we wanted to use it.

486 x-Q. Between the time of leaving Centre street and going to Walker where were the tools, apparatus and machinery referred to, kept.

A. I think they were stored at 43 Centre street, ex-

cept dynamo lamps, switches, and apparatus of deli- 2025
cate character. The dynamo was taken and set up at the corner of Centre and Howard streets, opposite No. 2 Howard street; the other things at my office No. 3 Mercer st.

487 x-Q. With whom were the things stored that were left at 43 Centre street?

A. I think they were left in the room that we occupied; packed up in one corner that was partitioned off for the purpose. 2026

488 x-Q. What power did you have at Howard street?

A. We had only the steam power in the building, which was also used for several buildings in the neighborhood.

489 x-Q. Did you have pulleys and shafting in that room?

A. No, sir; they were all in the room occupied by Arnoux & Hochausen.

490 x-Q. How did you get the current that you used 2027
there?

A. From dynamos in a room of Arnoux & Hochausen, our own and different ones belonging to them, from which wires were led to an office room of Arnoux & Hochausen, and from thence directly to our room underneath. Lamps were set up part of the time in Arnoux & Hochausen's room, but mostly in our room underneath; the regulators, resistances, switches and measuring instruments, etc., were all in our room; we
had no dynamo in our room. 2028

491 x-Q. How were the dynamo machines from which you obtained your current, driven?

A. By pulleys and shafting in the building; we did not put up any pulleys and shafting; we may have changed it around to get the velocity we wanted, and connect it to our counter shaft with fast and loose pulleys.

2029 492 x-Q. Which of the dynamos that you had at Centre street did you use in Howard street?

A. The one that was bought of Arnoux & Hochausen, and one or more that we borrowed from them.

493 x-Q. Then none but Arnoux & Hochausen machines were used, as I understand it?

A. I don't recollect any but Arnoux & Hochausen machines were used; I suppose that all these machines would be more properly designated Hochausen ma-
2030 chines, as they were devised by him; built as I understand by Arnoux & Hochausen.

494 x-Q. Wi h the exception of the machine mentioned in the bill you have produced were these machines the type of machine at that time manufactured by Arnoux & Hochausen?

A. Yes, for electro-plating mostly, excepting the one which they wound especially for our use.

495 x-Q. Was the one they wound specially, the one referred to in the exhibit?

2031 A. It was not the one referred to in the exhibit, but another machine, and was by them delivered to us; but Arnoux & Hochausen desired to sell us a machine and to experiment in machines for incandescent lighting, and so wound one or more machines for our use; they had no incandescent lights and we had; it was, therefore, a matter of mutual advantage.

496 x-Q. Which was it, one or more machines that was wound as you have described in your answer?

A. I think one for our special accommodation.

2032 497 x-Q. Was this winding done at their suggestion or according to their ideas, or at your suggestion and according to your ideas?

A. According to the joint ideas of Mr. Sawyer and Mr. Hochausen. I do not think I had anything to do with it except to ask or suggest its being done.

498 x-Q. Am I correct in understanding that this machine was made while you were at Howard street?

A. It was wound while we were there.

2033

499 x-Q. Was it ever used by you, and if so where?

A. It was used by us, while we were at the place, No. 2 Howard street, for a short time; it was then resold by Arnoux & Hochausen, as I understand it, for electro-plating business.

500 x-Q. Am I correct in understanding that with the exception of the machine referred to in the exhibit, and the one last mentioned, the only machines used by you in Howard street were the electro-plating machines at that time sold by Arnoux & Hochausen? 2034

A. Yes.

Witness states that having obtained from Mr. Broadnax an account made by the witness against the Electro Dynamic Light Company, which includes the rent paid for the premises at Nos. 2 and 4 Howard street, and shows that the occupation of those premises commenced on or about June 20th, 1878, and that the last payment of rent was on September 27th, 1878. That he also obtained from Mr. Broadnax the lease of 94 2035
Walker street to the said company, which is dated Oct. 15th, 1878; that deponent's recollection of the date of going to Walker street is confirmed by these papers and by the fact that we moved directly from the Howard street place to the Walker street place, and that it was some time after going there before the lease was executed. This same account also confirms my recollection that a large amount of work was done at Howard street, and contains items paid for that work, notably for glass moulds to Homer Brooks, for glass globes to P. Schneider & Sons, Archer & Pancoast, for fixtures 2036
Arnoux & Hochausen, for work, other items for material; payments to Mr. Sawyer, for expenses incurred by him, etc.

I have also found an entry in my check book, dated April 6th, 1878: "1878, April 6th, Charles " P. Fizer & Co., quicksilver, 81 Maiden Lane, Electric Light, $27.25;" so that I know we bought quicksilver of

2037

P. Fizer & Co., and that I paid for it with my check on April 6th, 1878.

501 x-Q. I understand you to say that you left Howard street the latter part of September or first part of October. Now, what was the nature of the experiments, if any, that were made by you from the 1st of September to the time of leaving Howard street ?

A. Experiments in the making of carbons, preparation and treatment of carbons after their manufacture; in making and purifying nitrogen and other gases; ex-
2038 periments in resistances and switches; experiments in dividing the current and in distribution and measurement; experiments in filling the lamps and treating the carbon in process of filling; experiments in exhausting lamps and lamps not exhausted; experiments in safety devices and cut-outs; experiments on globes of different sizes and forms, and generally getting ready to manufacture electric lamps upon a commercial scale and put them in use.

502 x-Q. Was the work done from the 1st of Septem-
2039 ber to the period of your leaving Howard street rather in the nature of getting ready to exploit and produce commercially the inventions which had been perfected, or to make experiments with the view of making inventions ?

A. Our object was to get our invention into shape for commercial use, and perfect plans and means of manufacturing, and also we were compelled to continually devise and invent new things.

503 x-Q. Did you consider that you had obtained a
2040 lamp which was practical and could be introduced commercially ?

A. We did.

504 x-Q. Who composed the force at the Howard street shops while experiments were going on ?

A. I do not think we had any workmen there except Mr. Sawyer's father and Mr. Sharp. We had a large amount of work done outside by the firm of H. L. Judd

2041

& Co., Arnoux & Hochhausen, by Miller and Newman and by various other people. Mr. George Sawyer was a kind of general utility boy; Mr. William E. Sawyer, Mr. Frank Holbrook, and Mr. E. L. Myers, with some assistance rendered by myself.

505 x-Q. What were the habits of these various people that you have named, as far as attendance at the shop was concerned during the period of September, 1878 ?

A. Mr. William E. Sawyer was supposed to be at the place all day, also George Sawyer, Holbrook was there, 2042
or at a place down in Broadway, near the Battery, for a fortnight, as near as I can recollect, with occasional visits to the School of Mines for half a day or so. Mr. E. L. Myers was there after Mr. Holbrook went away, or in the place down toward the Battery, or at Stevens' Institute. I do not recollect how much Mr. Sawyer's father was at the place. Sharp was there only a day or two, as I recollect, and did most of his work at his shop near my house in Brooklyn. I was in the habit of going to the place every day, whenever I could find 2043
time to do so.

506 x-Q. Was Mr. William E. Sawyer at the place all day, and every day during the month of September ?

A. I cannot state at this length of time whether Mr. Sawyer was there every day and all day, or not. I can only say that from the time that he returned from his vacation, and we got to work there in the latter part of August or first part of September, until we went to Walker street, he was very attentive to work, and 2044
worked very hard, and I have no recollection of his being absent from his duties which were to be there and to be engaged in the work of the company.

507 x-Q. What were Holbrook's habits as to attendance there ? also, Mr. Myers' and your own ?

A. Holbrook's habits as to attendance depended

2045
whether his work was there or elsewhere. He came about 9 A. M.; was engaged upon chemical work and experiments for the company. For lack of apparatus and convenience, he sometimes went to work at the laboratory of the School of Mines, of which he was a graduate, and sometimes went down to the place near the Battery. He was industrious, and usually worked until dark. Myer's employment was similar to that of Holbrook's with the addition of doing some electrical
2046 work and measurements. He was in the habit of getting in about 9.30 A. M., and leaving at 4.30. He worked at Howard street, at the place down Broadway, or at the Stevens' Institute, of which he was a graduate. I was at the place sometimes in the morning, on my way to my office, for a few moments; sometimes at noon, sometimes at night, sometimes morning, noon and night, after business hours. My attendance there was very irregular; and sometimes instead of going there, I sent for Mr. Sawyer to come and see me.

2047 508 x-Q. What was the apparatus to which you refer which made it necessary for Mr. Holbrook to go to the School of Mines?

A. Chemical apparatus, such as pumps, tubing, glass holders, retorts, stopcocks.

509 x-Q. What kind of pumps do you mean?

A. Air pumps.

510 x-Q. Did you not have apparatus of the character mentioned at the Howard street shop?

A. Yes, I think so; but both Holbrook and Myers
2048 thought that the apparatus at the colleges were better and more convenient than we had, and thought they could do better work there, especially such work as they might desire for subsequent experimental tests. Our lamps were made to be put up and taken apart, sealed and unsealed. We were in the habit of filling them and of running them lighted, both lamps filled with nitrogen gas of ordinary atmospheric pressure,

and also after filling with gas and exhausting to a dif- 2049
ferent degree of exhaustion, and also when exhausted not having been filled. We tested them while running, while lighted, and being run; by throwing a picture of the lighted carbon on a screen and watching the effect of the atmosphere of the lamp on the carbon, and after the lamp had been run for awhile, we tested the atmosphere of the lamp chemically, to ascertain what change had taken place in the atmosphere of the lamp or carbon burner on both; and it was with reference to those 2050
delicate tests that these gentlemen went to their various colleges.

511 x-Q. What was the rent of the room in Howard street?

A. Ten dollars per month.

512 x-Q. What was the reason for leaving the Howard street shop?

A. Want of room and facilities for doing work.

513 x-Q. Please state the size of the laboratory at Walker street and Elm, and who composed the work- 2051
ing force there?

A. One loft about 20 by 50 or 60, the same working force as Howard street, except that Mr. Holbrook only worked, if at all, for a few days there. The elder Mr. Sawyer, E. L. Myers and Mr. Sharp were there all the time. Machinists and workmen and instrument makers were hired from time to time, and Mr. Lawrence Myers was there about a month.

514 x-Q. What was your habits as to attendance there? 2052

A. I was more attentive during the month of October than at Howard street, spent a good deal of time there, and did some work, chemical and testing myself. Afterwards Mr. Lawrence Myers came to relieve me of the necessity of being at the shop so much.

515 x-Q. What tools, machinery and apparatus did you have at the Walker street laboratory?

A. We had a very complete set of machinists' and

2053 instrument makers' tools, a partial set of carpenters' tools, a miscellaneous lot of bench tools of all kinds for doing all sorts of things—working in wood, metals, stone and carbon. A pretty complete chemical laboratory, with pumps, retorts, furnaces, piping, tubing, stop cocks, pinch cocks, and other chemical apparatus; two dynamos, two engine lathes, lathe tools and gearing, steam engine, pulleys, shafting and belting, electrical instruments, photometers, electrical testing and measuring apparatus, lamps, switches, resistances; electro-plating baths and apparatus, electric batteries,
2054 lenses, etc., etc.

516 x-Q. I understand that the Walker street laboratory was given up in March, '79,, and that the experiments of Sawyer and Man at that period ceased. Am I correct?

A. Yes, sir.

517 x-Q. What was the nature of the experiments conducted at Walker street, speaking generally?

A. They were for the purpose of perfecting and ex-
2055 hibiting a system of incandescent lighting with all its necessary accessories, and getting it ready to introduce in practical operation.

518 x-Q. What were the dynamo machines used by you in Walker street?

A. One that we bought while in Centre street, mentioned in Defendants' Exhibit No. 1, Dynamo Bill; one or two machines which we borrowed of Arnoux & Hochausen for trial, of their largest size of lighting machines, and one large machine which we bought of
2056 them in September, which was specially wound for us.

519 x-Q. The one or two lighting machines which you speak of having borrowed for trial, were they actually used by you, and if so, for what period and how long a period?

A. They were used by us while we were there; my impression is from about the middle of October, but

for how long I cannot recollect. It seems to me, however, that one of them was there in March, 1879, at about the time that we left. 2057

520 x-Q. What do you mean by saying these machines were on trial?

A. I mean just what I say, that they were on trial for the purpose of incandescent lighting, and to see what their efficiency were for that purpose. You will remember that at this period dynamo machines were not made ordinarily for incandescent lighting. 2058

521 x-Q. Were these machines, after being tried, regarded by you as efficient for incandescent lighting?

A. None of them except the one that was specially wound for us; the one ordered in September, that was a good machine; the others would light a few lamps, but their electro-motive force was too high and the quantity too low.

522 x-Q. Is it then the fact that the lighting machines to which you have referred, after being tried by you, were found not to be adapted to your lamps, and other 2059
machines were used?

A. We could use them, but they were not specially adapted to our lamps—not so well adapted as the machine made in September, and the one mentioned in the Exhibit "Dynamo Bill."

523 x-Q. Who ordered the machine of Arnoux & Hochausen in September?

A. I did; as President of the Electro Dynamic Light Company.

524 x-Q. You speak of having an engine. Whose 2060
make was it, and when was it bought?

A. It was known as a Hampton steam engine; was bought from a firm in Liberty or Dey street about the time we went to Walker street. It was a six horse-power engine and was run by Wm. Sawyer, Mr. Sharp and George Sawyer also, who got a license while we were there.

525 x-Q. After the formation of the Electro-Dyna-

2061 mic Light Company on July 11th, 1878, was such experiments as were conducted and such apparatus as were purchased at the expense of that company?

A. Yes, sir; I think so for the most part.

526 x-Q. Did that Company keep books of account?

A. Yes, sir.

527 x-Q. Where are the various books of account, minute book, and records of that company, and in whose possession?

2062 A. I don't know; they were in the possession of Mr. Amos Broadnax, Counsel.

528 x-Q. Have you any connection with that company at the present time?

A. I am a stockholder and director.

529 x-Q. Do you know who is President, Secretary, and Treasurer of that Company?

A. Mr. Thomas Wallace is President, Jacob Hayes is Treasurer, Lawrence Myers is Secretary, I think, but I don't know.

2063 530 x-Q. Will you produce the books of account containing the minutes of the Board of Trustees of that company, or endeavor to cause their production.

A. They are not in my possession nor under my control, and I don't know where they are, and am not able to produce them.

531 x-Q. Could you not ascertain where they are?

A. I don't know whether I could, or could not.

532 x-Q. Will you endeavor to ascertain in whose possession the books are, and give the results of your efforts?

2064 A. Not unless I am instructed by Counsel or the Court that I am under obligations to go and hunt these things up and try to find where they are, or try to get possession of them, when I have no right to such possession.

533 x-Q. Are not your relations to that company and its successors, its Counsel, and the Counsel of its successors, its officers and various Directors, such that

you could, without any difficulty ascertain the whereabouts of such books? 2065

A. Not, except as a personal favor to myself, which I do not wish to ask for, and not then, even as a personal favor, without consent of complainant or its Counsel.

Counsel for defendants state, that he desires the fullest investigations made into the inventions and experiments of Sawyer and Man, and for that purpose desires to inspect the books referred to, and therefore requests complainant's Counsel to produce, at the earliest possible time, all the account books, vouchers, bills, letters and other papers, relating to such experiments and inventions during the existence of the Company referred to, and kept by, or in possession, or under the control of the Electro-Dynamic Light Co. 2066

Counsel for complainant responds that thus far the so-called cross-examination has been a mere fishing excursion on the part of defendants' Counsel, in the hope of finding something that will aid defendant in making a case: that none of the quesitons and answers given to and made by the witness, have any pertinency, relevancy or competency upon any of the issues in this case, nor upon anything brought out by the examination-in-chief, and that he does not mean to produce any books or papers which have no pertinency or relevancy upon the issues of the case, merely to gratify the curiosity of the defendant, or its Counsel, and shall not produce any books or papers unless ordered to do so by the Court, which in his judgment are not material to some of the issues raised by the pleadings in this case; that he has as earnest 2067 2068

2069 a desire for the fullest investigation of all the facts pertaining to the issues of the case as defendants' Counsel, but objects to putting in the record a mass of irrelevant matter, which can have no other effect than to confuse, perplex and mislead the Court.

Defendants' Counsel requests Counsel for complainant to state in whose possession the books of account and the minute books of the
2070 Directors or Trustees of the Electro Dynamic Light Company are.

Complainant's Counsel declines to gratify defendants' Counsel's curiosity, but adds that if defendants' Counsel can show that any of of the books of the Electro Dynamic Co., and over which complainants' Counsel has any control, possesses any evidence material to defendant upon any issue in this controversy,
2071 he will do all that he can to cause their production, or to produce them himself.

Defendants' Counsel replies that he cannot tell whether the books contain any such evidence until he has had an opportunity to examine them, and he desires to examine them to ascertain such fact.

Defendants' Counsel offers in evidence an account produced by witness, and also a lease from Elizabeth C. Jay to the Electro Dynamic
2072 Light Co., and it is agreed that copies may be substituted for the original; the same are marked "Defendants' Exhibit Accounts and Jay Lease."

534 x-Q. I now hold in my hand which purport to be a copy of an agreement made between yourself and William E. Sawyer, dated March 19, 1878. Please look at the paper to which I refer, and state whether the Electro Dynamic Light Co. was such a joint stock

company as was contemplated in the agreement referred to? 2073

A. The Electro Dynamic Light Co. was formed pursuant to an agreement and understanding between Mr. Sawyer and myself, up to the time of its organization.

535 x-Q. On March 19th, 1878, had any joint inventions been made by Sawyer and Man?

A. Yes, sir; but up to that time I don't think that either Mr. Sawyer or myself had considered for a moment whether these inventions were joint or several. 2074

536 x-Q. Did you not at that time, March 19th, 1878, consider such inventions, as had been made in subjects in which Mr. Sawyer had been conducting experiments, either alone or assisted by you, as the sole invention of inventions of Mr. Sawyer?

A. I do not think I gave it any consideration whatever, one way or the other.

537 x-Q. In view of the contract made on the date referred to, should you not say that it was your opinion at that time, that such inventions as had been made were the sole inventions of Mr. Sawyer, and such was his opinion?

A. If I look at nothing but that bare paper, dated March 19th, 1878, I might come to such conclusion, but in view of the facts as they existed and were known by both Mr. Sawyer and myself, I am confident that the authorship of invention was not one intended to be dealt with specially by that instrument. I am confirmed in this view of the subject matter from a subsequent statement by Mr. Sawyer, in my presence, 2076
to Mr. Broadnax, at the time when the application for the patent in issue in another case, in October, 1878, was made, and in which interview both Mr. Sawyer and myself stated, as nearly as we possibly could, the facts about the invention, what each of us did, and took his advice as to whether the applications should

2077 be in Mr. Sawyer's name, in my name, or in our joint names, which advice we followed in making applications for our patents.

538 x-Q. Was this conversation with Mr. Sawyer the first discussion whether your inventions had been joint, or were the separate inventions of Mr. Sawyer?

A. No.

539 x-Q. In view of the agreement made between you May 11th, 1878, which refers to the agreement of March 19th, please state whether it was not your
2078 opinion, at the time of the agreement of May 11th, and Mr. Sawyer's also, that the question of joint inventorship referred only to inventions made after March 19th, and in regard to those made before that period, they were the sole inventions of Mr. Sawyer.

A. No, sir; the agreement of March 19th is referred to in the agreement of May 11th, only for particulars, and in the second clause of that agreement, a reference is made to a prior agreement, and the plans proposed by Mr. Sawyer, and that second clause is the
2079 one stating the fact of my participation in the inventions. In explanation I wish to further say, it was not until after March 19th that it was demonstrated that the plans proposed by Mr. Sawyer therein referred to were futile.

540 x-Q. What were the plans of Mr. Sawyers which you say were shown to be futile?

A. At this length of time I do not know that I can specify. I can only say that about the last days of March, 1878, Mr. Sawyer having failed to get anything
2080 ready to exhibit to my friends and myself, although I had aided him by suggestions, money and advice up to that time, was in despair about producing a light that would be satisfactory, and wanted more time to do it, and besought me not to leave him, as I was intending to do, and said if I would stick with him and help him that the thing could be worked out; and at that

time it was considered that the plans he had proposed originally had failed. 2081

541 x-Q. Cannot you give me any idea whatever as to those plans?

A. There was a lot of things, and I do not remember what they were; different forms of lamp; one, I remember, that the oxygen might be burned out of the air sufficient with phosphorous to leave a practical atmosphere of nitrogen for an incandescent lamp, and that a simple glass stopper, like a bottle stopper, would 2082
be sufficient sealing for the lamp. Another was burning out the oxygen in the lamp, and absorption of the carbonic acid by water. Another was that hydro-carbon gas would be a suitable atmosphere for an incandescent lamp. Another was that no special peculiarity of switch would be required. Possibly other things would occur to me, but these were some of them.

542 x-Q. Is it, then, true, that in the latter part of March, 1878, Sawyer had failed to get anything satisfactory, and was in despair about getting up a light, and 2083
that you intended to leave him, and give the matter up?

A. It is true that up to that time I was not satisfied, although I saw at the same time great promise in many things we had done; and that I expressed to Mr. Sawyer my views on the subject, and that he expressed himself to me as in despair of accomplishing anything if I should leave him, and besought me to stay with him and help him, and, contrary to my better judgment, I did, and have been sorry for it that I did. 2084

543 x-Q. It is, then, true, that up to that time you had not accomplished anything?

A. No; it is not true that we had not accomplished anything. We had accomplished much, but we had not struck upon what I considered a practical system of incandescent lighting, and the things which Mr. Sawyer had proposed, had, it seems to me, proved worth-

2085 less, and what we had done that was of value up to that time, it seems to me, was the result of my own suggestions and work with Mr. Sawyer, and I told him so.

544 x-Q. What was the cause of your dissatisfaction at this time?

A. Failure in accomplishment on the part of Mr. Sawyer.

545 x-Q. Failure in accomplishment of what?

A. In the making of a practical first-rate incandescent lamp with its accessories for an incandes-
2086 cent lighting system, and in what seemed to me a want of proper diligence and skill in the prosecution of the attempt. I can best illustrate it by saying that it seemed to me that when I was personally present and aiding and pushing the thing, things did not seem to progress and seemed to me to remain at a standstill.

546 x-Q. Did you anticipate, when you first made your arrangement with Mr. Sawyer, that as early as the latter part of March, or within a month from the time experiments were begun, "a practical, first-rate
2087 incandescent electric lamp with its accessories for an incandescent lighting system," would be obtained?

A. I had anticipated that it would be done before the last of March.

547 x-Q. Were you impressed with the fact that on the part of Mr. Sawyer there was a want of proper diligence and skill in the attempt to obtain such a lamp and its accessories, as far as he was concerned?

A. I have already testified that such was my feeling in regard to the matter; whether it was a fact or not,
2088 might be a question of dispute.

548 x-Q. Was it your impression at the time referred to that Sawyer was not attending to his work diligently?

A. I have, I think, answered that question as fully as I can.

549 x-Q. In what respect did you consider Sawyer lacking in skill?

A. Particularly in a knowledge of chemistry and its 2089
manipulations, and in mechanical adaptations and proportions, and in neglecting to note and profit by failures in experiments.

550 x-Q. You say Sawyer was lacking in what seemed to you a want of proper diligence in the prosecution of the attempt. How was this manifested? By absence from the laboratory or from inattention to work when there?

A. I do not know that I felt any dissatisfaction as 2090
to Sawyer's attendance at the laboratory, nor that he was not busy enough.

551 x-Q. What do you mean by your answer when you say, "when I was not personally present, and aiding and pushing the thing, things did not seem to "progress, and it seemed to me to remain at a standstill"? I also call your attention to the other portion of the answer in which you say you were dissatisfied with Sawyer because of a want of proper diligence
in prosecuting the attempt. 2091

A. I mean just what I say, exactly; I cannot better illustrate it than by reference to the common expression, "a man is very busy and does nothing," not that I mean to say Mr. Sawyer did nothing or accomplished nothing, but that his accomplishments were not satisfactory to me, and it seemed to me to be due to a lack of proper and diligent, persistent and well-directed attempt.

552 x-Q. Now, just what do you mean; was Sawyer
diligent and industrious in his work, or was he not? 2092

A. He seemed to be always busy; I cannot better express it.

553 x-Q. Were you satisfied or dissatisfied with the result of his labors?

A. I was not satisfied.

554 x-Q. What caused you to continue to assist him, and why did you alter your conclusion to give the matter up?

2093 A. I think, as near as I can recollect, that I was influenced by Mr. Sawyer's urgent request and his confident statement that if I would remain with him and assist him we could work the matter up to a practical and successful conclusion.

555 x-Q. When did differences first arise between yourself and Mr. Sawyer, and when were his habits of intoxication and dissipation first discovered or ascertained by you?

2094 A. As near as I can recollect, the fall of 1878, while we were at the corner of Walker and Elm streets.

556 x-Q. When did Sawyer first begin to neglect his work?

A. I now think that his habits interferred with his work all the time, but the first cause of complaint on my part of his conduct arose from his absence and nearly entire inattention to the work of the company while I was gone on my vacation in the Summer of 1878.

557 x-Q. After the first complaint was not Mr. Saw-
2095 yer's inattention to business and dissipation almost continuous from that period?

A. No, sir.

558 x-Q. I understand that Sawyer quarreled with the Electro Dynamic Light Co., and was the cause of a great deal of trouble to you and the various organizations with which he was connected, and became so dissipated as to utterly neglect his business. Now, please state when it was Sawyer's dissipation became known to you, how it became known, and what effect it had
2096 upon his attendance at your different laboratories, and upon his work while there?

A. Without consenting to your understanding, as stated in the question, exactly, I proceed to answer: My first knowledge of his dissipated habits and character, as near as I can recollect, was derived from information conveyed to me, I think, in October, 1878, of his conduct while I was absent on my vacation. I

2097 was told he had been on a spree, or a succession of sprees, during all this time. From this time forward I noticed from time to time in the morning, when I saw him at the shop, that he had been drinking. His dissipation was not such at any time while we were at 94 Walker street as to interfere with his ordinary attendance at the factory. I don't now recollect that I attributed any absence from the laboratory to dissipation, but perhaps I did at the time. Up to, I should now say, the 1st of November, 1878, I should 2098
think the effect upon his work while at the laborator was confined to the effect of drinking before coming there, and not while at that place. While there I do not think he was drinking, certainly not to excess. From this time forward, that is, from about the first of November, the habit of drinking increased upon him, and interfered with his work so that I was compelled to give more time to the shop or laboratory than I could well spare from my other business, and finally, I 2099
think in December, Mr. Lawrence Myers went to the shop and staid there continuously day after day in order to relieve me and exercise a restraining influence upon Mr. Sawyer; it resulted at last, in the month of March, 1879, in the workshop of the company being closed up and the work being transferred to the shops of Wallace & Sons, at Ansonia, Conn., where Mr. Sawyer was to give his time and attention, for, I think, a period of four months. His conduct while there was such, both from habits of drinking and other dissipation, that Mr. Wallace, who had become President of the 2100
Electro Dynamic Light Co., made complaint of the same to the Board, and refused to go on with him, and it was decided that this work should go on under the charge of Mr. E. L. Myers, who had been in our employ, and who was the only one except Mr. Sawyer and myself who understood all the details of our work and plans. Mr. Myers was taken sick and died, and

2101 after awhile the patents of the company were assigned to the Eastern Electric Manufacturing Co. This company had Mr. Sawyer in its employment, and had great trouble with him by reason of his intemperance and dissolute habits, and its patents were assigned to the plaintiff in this action, with whom Mr. Sawyer was never associated.

560 x-Q. Is it not the fact that Sawyer's habits and dissipation, after November 1878, were of such a character as to seriously interfere with his work?

2102 A. Yes.

561 x-Q. From your knowledge of Mr. Sawyer, in a case where it was his interest to made a false statement, is it your opinion that he would do so?

A. I think it would depend upon his surroundings and circumstances at the time the statement was made, and his condition at the time.

562 x-Q. From your knowledge of Mr. Sawyer, where it was, or he considered it to be, for his interest to make statements which were false, or to create the be-
2103 lief in others that things which were not facts existed, is it your opinion that he would do so?

A. I answer as before.

563 x-Q. Please explain your answer?

A. I mean that he would sometimes make, under certain conditions and circumstances, either false or true statements which were against his own interests, and he might be influenced in telling the truth or falsehood by passion, revenge, hatred, gratification of appetite, a desire to have his own way, or by conscience,
2104 remorse or desire to make amends.

564 x-Q. Would he make false statements in his own interests, or what he thought to be his own interests?

A. I do not think he was a reliable, truthful man. I do not, however, think that self-interest alone would be sufficient inducement for him to tell a falsehood.

565 x-Q. Do you think that Sawyer, if driven by necessity, could obtain money by making untruthful statements, or by deceiving the people from whom he expected to get it, would do so? 2105

A. During the latter part of his life, driven sometimes by necessities brought upon himself, and sometimes by a desire to obtain means to gratify his appetites and passions, I believe him capable of doing so.

566 x-Q. Do you think he was capable of causing the formation of a company and the investment of money 2106
and the payment of money to himself to exploit inventions that he knew to be valueless, and would represent that he possessed patents which he knew to belong to others?

A. Not from self-interest alone, but from hatred, malice, revenge or spite, to have his own way and accomplish his own or ulterior purpose—yes.

567 x-Q. Is it not the fact, whatever the motive may have been, that Sawyer did cause the formation of a company representing that he possessed inventions 2107
which he knew that he did not?

A. I believe it to be true. I do not know now that, from my own knowledge, I am able to assert it as a positive fact. I have tried to forget as much as possible these things against Mr. Sawyer. I believe that a refreshment of my recollection would compel me to assert it as a fact, but I don't want to do so.

568 x-Q. Did you ever know of Sawyer's blackmailing one or more of the companies with which he
and you were connected, and obtaining money from 2108
them by threats, and compelling the payment of money to himself by false representations or threats?

A. I believe he did.

569 x-Q. Was not Sawyer a man of utterly bad character, capable of dishonest or dishonorable acts?

A. No; not until at least the latter part of his life-

2109 time was he *utterly* bad. He died in 1882, and, indeed, I don't think he was *utterly* bad ever; he loved his little children, even then. He was capable of, and did, in the few last days of his life, send for a friend whom he had injured, and when that friend refused to go to see him, sent word that he did not want money, but wanted his forgiveness. Nevertheless, he was very bad, and did not hesitate afterwards to malign this very friend. No; he was not *utterly* bad.

2110 570 x-Q. Do you mean that he was not utterly bad until the latter part of his life, or that you did not know that he was.

A. I knew that he was very much worse during the latter part of his life, and that I did not know of his being a bad man in 1878, except for his inebriate habits.

571 x-Q. Have you ever known of his committing perjury?

A. I don't think I can say of my own knowledge in-
2111 dependently, that he committed perjury.

572 x-Q. Do you think he was capable of doing so?

A. I have already answered that question in my answer or answers, as to his truthfulness. I will answer in the same way, adding that, if the circumstances were such as to induce him to do it, I think he might have done so.

573 x-Q. Are you familiar with what was his general reputation for truth and veracity among his business associates in the various companies that have been
2112 mentioned?

A. I do not know that I would be a competent witness upon that point. My knowledge of his reputation was somewhat limited; however, I know something of it.

574 x-Q. From your knowledge of his general reputation for truth and veracity would you have believed him under oath?

A. From my knowledge of his reputation, speaking

from that alone, without any reference to my personal 2113
knowledge of the man, I should say that it would be necessary to know his circumstances, surrounding and the influences at work upon him at the time of his declaration under oath before I could say that I would believe or disbelieve him.

575 x-Q. Prior to your association with Mr. Sawyer did you consider yourself an electrician?

A. Only theoretically; I was not a practical electrician. My main knowledge derived only from reading 2114
and observation. It had been a favorite study of mine for some years before that time. I had considered the subject of electric lighting in connection with other matters of electrical interest only—not as a specialty.

576 x-Q. Did you read or were you familiar with such patents on the subject of electric lighting, either by the arc or by incandescence as had been taken out prior to your connection with Mr. Sawyer?

A. I do not as patents. I had read and was familiar 2115
with the labors and investigations of others relating to this subject, so far as the same as published had come to my attention in the scientific journals and reports.

577 x-Q. Had they come to your attention to a sufficient degree to familiarize you with the labors and investigations of others in this art?

A. I think so, to a very considerable extent.

578 x-Q. At the time of your meeting with Mr. Sawyer was he familiar, in your judgment, with the labors and investigations of others in this department? 2116

A. He seemed to me to be quite familiar with the history of the subject.

579 x-Q. Referring now to the dynamo machines, which you used in your experiments, I understand your recollection to be as follows: That for the first two or three days at Centre street there was an Arnoux & Hochhausen light machine in the basement of the building; that after that was removed, and until

2117 March 25th, you borrowed some plating machines from Arnoux & Hochausen; on or about March 25th a specially wound machine was delivered; that after you went to Howard street and from there to Walker and Elm streets another specially wound machine was obtained; and from then on you used the specially wound machines, and occasionally one of Arnoux & Hochausen's plating machines. Is this correct?

A. The exact details will better appear in my testimony as given.

2118 580 x-Q. Describe in detail the construction of the machine which was specially wound for you in Centre street and delivered to you March 25th?

A. I cannot do so without the machine being present.

581 x-Q. Do you not remember them sufficiently well to describe it?

A. No, not in detail.

582 x-Q. Describe it as well as you can?

A. It was an ordinary type of Siemen's H armature
2119 dynamo, about two and a half or three feet long, and the same height, say two and a half feet.

583 x-Q. Please state the construction of the field magnets of this machine?

A. I could not do it.

584 x-Q. Were they permanent or electro-magnets?

A. Electro-magnets.

585 x-Q. How were the magnets energized in your experiments with this machine?

A. Ordinarily by the current evolved by the machine,
2120 but in some experiments by a separate machine.

586 x-Q. Please describe completely the connections made where the magnets were energized by another machine, and where they were energized by the machine itself?

A I cannot recollect the details of these connections more than any other electrical connections.

587 x-Q. If this machine were now before you, 2121
would you be able to make the proper connections to energize the field by the machine itself, or in the other case by a separate machine?

A. I think so; if the machine was so constructed as to permit it.

588 x-Q. Please state what you would do to make the connections suggested, and illustrate the same by a sketch?

A. I do not know how you could expect me to con- 2122
struct a machine of which I have told you I have no recollection of its details. I decline to do it.

589 x-Q. Please describe the "ordinary Siemen's H armature machine?

A. I have never built a dynamo. I have never made any invention of a dynamo; my knowledge in regard to dynamos is wholly theoretical, derived from books and descriptions; in giving a description of Siemen's H armature machine, I am liable to omit details and perhaps essential parts. If you desire to have me 2123
make a description I will do so as well as I am able.

590 x-Q. Describe the ordinary Siemen's H armature machine?

A. Suppose an iron frame in the form of the letter H, pivoted on a shaft parallel to two sides of the letter and midway between them, the cross-piece of the H extended so as to give it more of the form of an ordinary reel for winding up yarn or fishing-line by hand. Let this iron frame be wound lengthwise be- 2124
tween the sides of the H with insulated copper wire until it assumes the form of a cylinder or nearly such, the two ends of the wire being brought out and insulated to near the ends of the axis where they are in communication with insulated semi-cylinder plates of metal, embracing and nearly surrounding the axis, called a commutator. Resting upon these and insulated, two brushes or spring plates touching opposite portions of the commutator plates last described; a

2125 pully connected to the axis of the armature, by which it may be driven; supports in which the axis revolves; field magnets, or magnets whose opposite poles substantially embrace the armature. These are the essential features of construction; the field magnets may be permanent magnets or electro-magnets, and in the latter case may be actuated by the current of the machine, a portion of the current in a shunt circuit, or by a current derived from a battery or other machine.

2126 591 x-Q. Are machines of this type always provided with commutators such as you have described?

A. I don't know that I have described any particular kind of commutator except such as is generally used; if no commutator were used the currents would be to and fro, or alternate.

592 x-Q. Please state the length and shape of the magnets of the specially wound machine to which we refer—that delivered in March, 1878?

A. I do not recollect them well enough to describe
2127 them with accuracy; I only recollect they were broad lengthwise of the machine and their poles projected upward.

593 x-Q. Please state the weight of the machine?

A. I don't know; two men could lift it.

594 x-Q. What was the size of the wire of the field and armature?

A. I don't recollect.

595 x-Q. How many turns of the wire were there on the armature?

2128 A. I say I cannot recollect the details; I never knew.

596 x-Q. What was the resistance of the armature and of the field?

A. I don't know.

597 x-Q. State approximately or as near as you can?

A. I have no recollection.

598 x-Q. In the experiments with this machine where the magnets were energized by the currents of

the machine, was the magnet connected in series with the armature or in multiple arc with it? 2129

A. I don't recollect whether the whole currents were sent around the field magnet or whether they were connected in a shunt circuit.

599 x-Q. Do you know what the difference between these two methods of connection would be, with reference to the electrical apparatus or lamps operated by the machine?

A. I don't think anybody could tell without a thor- 2130
ough knowledge of the machine in a given case, and without a knowledge of the number of appliances, their resistances and relation to the circuit, and without knowing whether the re-entering point of the shunt was before or after the appliances to which you refer in the general circuit.

600 x-Q. Answer me with reference to the machine in question and to the experiments of Sawyer and Man?

A. I do not recollect how it was connected, and 2131
therefore cannot tell you how it operated one way or the other.

601 x-Q. What was the electro-motive force of this machine?

A. I don't recollect; I guess some twenty-five or thirty volts; it may have been much more or it may have been less.

602 x-Q. And you don't now recollect it?

A. I don't know.

603 x-Q. Do you mean to say that you cannot state 2132
what the electro-motive force of the machine was, that was specially made for you, and used by you throughout your experiments?

A. I do mean to say that I cannot recollect what it was.

604 x-Q. Will you swear that it was over five volts?

A. I think that it was very much more than that;

2133 but I do swear at the same time, I don't know anything about it.

605 x-Q. What was the E. M. F. of the machine that you borrowed from Arnoux & Hochausen in Centre and Howard streets?

A. I don't know.

606 x-Q. About what.

A. I don't know.

607 x-Q. Can you not give any idea?

A. I have no recollection.

2134 608 x-Q. More than one volt?

A. You have exhausted my recollection in regard to this matter, so far as giving details of electrical measurements is concerned, the machines we used were perhaps not all of them measured, and I don't recollect them with sufficient accuracy to give the details of their electrical measurement in any case; it would, however, from the work they accomplished, as a general rule, be absurd to estimate the electro-motive force of any of them so low as one volt, as it seems to me.

2135 609 x-Q. Was it more than two volts?

A. I have nothing to add to the explanation I have just made.

610 x-Q. Was it more than three volts?

A. I think the machines we used would probably be estimated from thirty to two hundred volts; you drive me to make a guess in regard to it; it is all that I can say; and I don't know that I am right.

611 x-Q. The machines you used have been specially pointed out in the testimony; what was the E. M. F.
2136 of the electro-plating machines borrowed by you from Arnoux & Hochausen, and which you say were a type of machines made by them and sold in the open market; do you mean to say it was between thirty and two hundred volts?

A. If they had been pointed out it has been an error on my part, for I have intended to be understood as

not recollecting specifically the different machines that 2137
we used; we did use plating machines, and those principally at the corner of Howard and Centre street, and part of the time at 43 Centre street; whether we used any other than plating machines at the corner of Howard and Centre streets I do not recollect, except our own first machine we used at 43 Centre street, and at 94 Walker street, lighting machines built by Arnoux & Hochausen; the E. M. F. of the plating machines was not high as compared with the lighting machines
nor as compared with our own machines built by Ar- 2138
noux & Hochausen, nor as compared with the machine whose field magnets were energized by another machine.

612 x-Q. Question repeated.

A. I don't know.

613 x-Q. Do you wish then to be understood as being able to give no idea whatever as to the E. M. F. of the machines which were loaned you and used by you in experiments; I refer to machines which you stated
were plating machines made by Arnoux & Hochausen, 2139
and sold for that purpose in the open market?

A. Your question implies inaccurately that I can give no idea, or have given no idea whatever in regard to the subject-matter. I therefore decline further to answer it.

614 x-Q. Please state what was the E. M. F. of the plating machines made by Arnoux & Hochausen and sold for that purpose in the open market, and which were borrowed by you and used in your experiments?

A. The E. M. F. of different machines which we bor- 2140
rowed and used, including the different plating machines, was widely different one from the other, and we coupled them to produce different E. M. F. as we used them, but I have no recollection whatever what the E. M. F. was—as a matter of recollection.

615 x-Q. I restricted my last question, and restrict

2141

this to such electro-plating machines as you borrowed of Arnoux & Hochausen. I wish to know what the E. M. F. of those machines—not other machines, but those machines—was. Please state.

A. The electro-motive force of these machines greatly varied one from the other. I mean the electro-plating machines that we borrowed and used. I don't know the E. M. F. of any of them. I don't know the highest E. M. F. obtained from any of them, nor the E. M. F. that
2142 could be obtained from any combination of them; nor the lowest E. M. F. of any one of them; nor the range by which the E. M. F. varied from the highest to lowest.

616 x-Q. Did you ever hear of an electro-plating machine of over 15 volts?

A. I don't remember to have ever heard the E. M. F. of any plating machine spoken of.

617 x-Q. Does not your investigation into this favorite study of electricity enable you to state what the
2143 E. M. F. of plating machines usually is?

A. I do not remember to have ever looked into the subject; doubtless Mr. Edison, from his experience with his electric meter, could give you the information you seek.

618 x-Q. Then, as I understand you, you have no idea whether the E. M. F. of these electro-plating machines was as low as half a volt or as high as 10,000 volts?

A. I have no question as to your understanding, and
2144 deny all responsibility for the same.

619 x-Q. Have you any idea as to the E. M. F. of the plating machines sold by Arnoux & Hochausen while you were at 43 Centre street?

A. I don't know what the E. M. F. of those machines, or any of them, was.

620 x-Q. Do you know whether it was above or below 15 volts?

2145

A. I think, as a rule, it was much above; I don't know.

621 x-Q. How much, then, do you think it was?

A. I have already said that I guessed their E. M. F. was 25 or 30 volts.

622 x-Q. Confining ourselves to the electro-plating machines which you borrowed while at 43 Centre street, of Arnoux & Hochausen, what is your best recollection of the number of such machines that were there? 2146

A. I don't recollect how many there were of them. There were several; I should think, in all, five or six different machines—possibly more.

623 x-Q. Were they of the same size and character?

A. Their type was similar, but some of them were very much larger than others.

624 x-Q. How did they vary as far as their electric effects were concerned, if at all?

A. Some of them were very much more efficient for 2147
lighting purposes, and would light up a much larger number of our lamps than others, and some of them would alone send a current through carbon for the first time, when it was being heated in hydro-carbon gas, sufficient to bring the carbon up to incandescence, and some of them would not—that is to say, both their electro-motive force and quantity greatly vary.

625 x-Q. Please state, as nearly as you can, within what limits this variation in electro-motive force and quantity was. 2148

A. I cannot give it in terms of electrical measurement.

626 x-Q. Have you no idea of it?

A. I have no recollection of it sufficient to express it in terms of accuracy or electrical measurement.

627 x-Q. Can you not give me any idea?

A. I prefer not to guess at the matter.

2149 628 x-Q. What I desire to know is whether it is true that while you were at No. 43 Center street you borrowed from Arnoux & Hochausen five or six different plating machines; second, whether these different machines differed in construction and electrical effect, or whether some of them, or all of them, were alike?

A. What I said, and intended to be understood, is that while at 43 Centre street we borrowed and used several machines of Arnoux & Hochausen of the gene-
2150 ral type and character of machines in appearance, which they built and sold for electro-plating; that I estimated their number at five or six—it may be more or less. It may be that not all of the machines were intended by them for electro-plating; they may have intended some of them for electric lighting, in which they were also engaged, but I took them to be, if I recollect right, their plating machines. The general construction of the machines, except one that was in the basement, and which they used for electric light-
2151 ing, and which they let us have the use of for a day or two, or so, was similar. I think there were three sizes of them; those of the same size were more nearly alike in electrical effect probably, but no two of the machines were alike in effect.

629 x-Q. I understand you to say that with the exception of the light machine in the basement, the five or six machines which you understood to be plating machines, and which you borrowed of Arnoux & Hochausen, were alike in construction, but were of three
2152 different sizes. Now, were these machines which were of the same size wound in the same way, with the same wire, and designed to be of the same effect electrically?

A. Excuse me from testifying to the accuracy or inaccuracy of your understanding. To your question alone I reply. I do not know how the machines were wound, nor with what wire. I only know that they differed one from the other in electrical effect.

630 x-Q. Were those machines which were of the

same size of such difference in electrical effect as to 2153
have been designedly so, or was the difference merely such as would exist between machines of the same size and character and intended to produce the same results?

A. I think the difference in electrical effect of machines of the same size, was due to design and experiments on the part of Mr. Hochausen, but I am not certain of this, and it may have been due to selection among different machines intended in construction to 2154
be the same.

631 x-Q. In machines of the same size, what was the difference in E. M. F.?

A. Some of these machines of the same size differed widely in E. M. F. I cannot give the difference in volts.

632 x-Q. As much as 100 volts?

A. I should think not, but as I have said, I don't know. If you wish me to guess I will do so, but it will be a guess.

633 x-Q. As much as 50 volts? 2155

A. I don't know.

634 x-Q. As much as 10 volts?

A. I think so; I don't know.

635 x-Q. As much as 15?

A. I think so; I don't know.

636 x-Q. As much as 25?

A. I think so; I don't know.

637 x-Q. As much as 40?

A. I guess so; I don't know. The average E. M. F. 2156
I have guessed at or estimated as 25 or 30 volts. It will not surprise me to know that some of these machines had not 5 volts of E. M. F., and that another machine of the same size and general appearance might actually have had in the neighborhood of 200 volts E. M. F.

638 x-Q. Do you mean that of these machines which you took for plating machines, and which were bor-

2157 rowed from Arnoux & Hochhausen, while you were at 43 Centre street, which were of the same size, may have varied in E. M. F. from 5 to 200 volts, and that you would not be surprised at such being the case?

A. I mean exactly this: that I never knew or heard of but one or two of these machines being measured. That I noticed in our experiments from time to time, a wide difference in the E. M. F. of these machines, and that if any competent electrician should have measured two machines of the same size and told me then or
2158 tell me now that one measured but 5 volts and the other measured 200 volts, I would not doubt, and would have no means that I recollect of now to doubt the accuracy of his statements, and the same would be true if he should report to me that one measured 3 volts and the other 30.

639 x-Q. What was the difference in E. M. F. of those machines which were measured?

A. I do not recollect.

640 x-Q. Can you give me any idea?

2159 A. No; and I don't know that two were measured, but think they were.

641 x-Q. What machine, or which machines were measured for electro motive force?

A. To the best of my recollection the machine we bought of Arnoux & Hochhausen and the machine we borrowed of them, and which seemed nearest like it in electrical effect.

642 x-Q. Do you know upon what the E. M. F. of a dynamo depends?

2160 A. I think I know some of the causes. I have never made a study of dynamos particularly.

643 x-Q. What are they?

A. Velocity of motion in the armature; size of the resistance in the wires of the armature; and density of magnetism in the field of the field magnets, through which the wires of the armature move.

644 x-Q. Please explain what the size and resistance

of the wires of the armature have to do with the E. M. F. of the machine? 2161

A. I do not propose to go into a theoretical discussion of electrical subjects.

645 x-Q. Do you decline to answer my question, or are you incapable of doing so?

A. I decline to answer it.

646 x-Q. Are you quite certain that you know the conditions which enter into the E. M. F. of a machine?

A. I do not think that I am called upon to discuss 2162 this subject matter with you or to express an opinion as to my own abilities.

647 x-Q. Question repeated. (Witness is silent.)

The witness has declined to answer, and is instructed by counsel not to undertake to testify as an expert on matters pertaining to dynamos unless he feels himself competent as an expert and unless the Court compels him, and counsel submits to the Court, whether, in 2163 view of the facts that the witness has testified, that he has not made any dynamos, or experimented with them, and knows nothing of them only as a matter of theory, he must answer the question.

The witness himself further objects, that he has not submitted himself to an examination-in-chief on the part of the defendant, and that if defendant desired to test the electrical knowledge of the witness, or to obtain expert testimony from him, he must obtain the consent 2164 of the witness to testify and pay him therefor.

648 x Q. Please state what you mean by density in magnetism in the field of the fields magnets in your answer.

A. The number of lines of force in the field of those

2165 magnets for a given space determines the density of the magnetism in that field of force, and the number of these lines is increased as the magnetism of the field magnets is increased up to the point of saturation.

649 x-Q. These machines which were borrowed of Arnoux & Hochausen, at 43 Centre street, had they any name or designation by which they were known in the business, and if so please state what it was?

A. I don't know of any.

650 x-Q. What was the weight of those borrowed
2166 machines; how did you get them into the room in Centre street, and who placed them there?

A. I never knew their weight; they were hoisted up in a hoistway to the floor on which our shop was. I think they were got into the room by old Mr. Sawyer, George and the men at work in the different shops there, and placed under the direction of Mr. Wm. E. Sawyer.

651 x-Q. The machine which was bought of Arnoux & Hochausen, while in Centre street, and which has
2167 been described as the specially wound machine, please state why it was specially wound; how it was specially wound, and what the effect of this special winding was?

A. As I have stated I do not recollect any of the details of this special winding. I only know that this machine was a very much more effective one than the others.

652 x-Q. Do you mean that you gave no instructions as to how you wanted the machine made but merely
2168 stated that you wanted a machine to produce certain results, leaving them to ascertain how such results, were to be brought about?

A. No, I don't think that that is quite right. I think it was about like this: We had tried several of Arnoux & Hochausen's machines, one of which was intended for arc lighting. We discussed with Mr. Hochausen

2169 the matter of building a machine which would be more effective for our purpose of incandescent lighting than any of those we had used. At the time I knew nothing about dynamos, except what little I had read, and the small experience I had obtained from the use of those that we had had so far. I don't know that any of us knew much about it. Mr. Hochausen had had the most experience and knew most, and I think they agreed to wind the machine over again if it did not prove satisfactory.

653 x-Q. What were the properties of a machine that 2170
you considered at that time as effective for incandescent lighting?

A. The one that would heat up the most lamps to the highest degree with the power.

654 x-Q. Was that the definite information that you conveyed to Mr. Hochausen?

A. At that time just as definite as that.

655 x-Q. Did you want high or low E. M. F.?

A. We thought we wanted a greater quantity of
current in proportion to its intensity than his arc light 2171
machines gave, and a greater intensity than the other machines gave, that is, less E. M. F. than the arc lighting machines and more than the plating machines.

656 x-Q. What amount of E. M. F. did you want to get by this specially wound machine?

A. We did not know ourselves.

657 x-Q. Did you know approximately?

A. No, only somewhere between the E. M. F. of the arc lighting machine and that of the plating machines,
as we judged from experiments. 2172

658 x-Q. Did you know what the E. M. F. of the lighting machines that were in the basement for a day or two and of the plating machines were?

A. No, only in effects, not in electrical units.

659 x-Q. Please state what the effects were which

2173 enabled you to judge of the E. M. F. of this light machine, and of the plating machines.

A. The one would light up several lamps of a high resistance, and would send a current through fine carbon before it had been treated and its resistance reduced; the little plating machine would heat up several lamps of low resistance with large carbons in them, after they had been treated, about as well as the large lighting machine, but would not send a current
2174 through carbon that had not been treated of high resistance without forcing to start it, by making and breaking the connections rapidly and suddenly.

660 x-Q. Was the specially wound machine of greater E. M. F. than the plating machines?

A. At first, yes; and it also gave a larger current under the resistance with which we used it.

661 x-Q. What do you mean by "at first" in your last answer?

A. Just what I say. It was re-wound several times.

2175 662 x-Q. How many different times was the machine wound, and by whom was it wound?

A. By Arnoux & Hochhausen, I think twice after the first winding, perhaps three times.

663 x-Q. What was it that was re-wound?

A. I think the armature alone at one time—perhaps the armature alone twice; once I think the whole machine was re-wound.

664 x-Q. State, as nearly as you now recollect, when these several re-windings were done?

2176 A. The first, I think, was soon after we first received it, and while we were at 43 Centre street. I think it was again wound while at Centre street. The final winding was while we were at 94 Walker street.

665 x-Q. Please state what the nature of the first re-winding was, and what effect it had upon the machines?

A. I did not see the work done, and therefore, can

only state generally what I understood was to be done, 2177
and what I assumed from the results was done. The armature was re-wound with finer wire and differently connected up, for the purpose of giving the machine greater E. M. F.

666 x-Q. What was the difference between the connections as re-wound and its connections prior to that time?

A. I can only answer as before from my understanding of what was to be done, and from the results ob- 2178
tained. I understood that the machine was to be coupled up more in series than before. I neither did this work myself, nor saw it done, nor supervised it. All that I had to do was to talk about it and advise about it beforehand. Judging from the effect, I assume it was done.

668 x-Q. Do you mean that now the armature was in series with the magnets, whereas, before, it had been in multiple arc with them, or that such was your understanding? 2179

A. No. I had reference to the armature alone. Perhaps my expression "more in series" does not convey a correct impression. The armature first being wound with coarser wire in several separate coils connected to the commutator; by the use of a finer wire, a larger number of coils was produced, occupying the same space, and having a greater length than the coils of coarse wire; they were connected up perhaps one coil to another in series, or two or more coils were united before connection to the commutator. 2180

669 x-Q. How much was the E. M. F. of the machine increased by this operation?

A. I don't know.

670 x-Q. Can you state approximately?

A. No; I can only state results; it was largely increased.

671 x-Q. About how long after the machine was first delivered was this re-winding done.

2181 A. I cannot remember, but my impression is not very long. My attention being called to this matter, my impression is that some change was made in the winding of field magnets soon after the first change in the winding of the armature of this machine, or it may have been before the change in the winding of the armature. I think the field magnets were first connected up in series with the armature, and that they received a compound winding in connection after we got
2182 the machine.

672 x-Q. What was the nature of the second re-winding, when was it done, and what was its effect?

A. I think the second re-winding was rendered necessary by burning out some of the coils of the armature of the machine. I do not remember that any discussion was had in regard to it, and as I did not give it personal attention I do not think I could give any other description of it. I do not remember that it affected particularly the working of the machine; if
2183 anything, it increased the quantity, but left the E. M. F. about the same.

673 x-Q. What was the nature of the third re-winding, when was it done, and what was its effect?

A. I think the third re-winding was done after we went to 94 Walker street. I only recollect about it, that it was our object at that time to get a machine of greater quantity current. I did not see it done, but assume that a larger wire was used in winding the armature in separate coils as before, more connected up
2184 in multiple arc to the commutator for the purpose of giving quantity than was the previous winding. I do not remember whether the field magnets were re-wound here or not; nor whether they were connected up differently from what they had been. We got a machine with a current of larger quantity and less E. M. F.

674 x-Q. Do you remember how much the E. M. F. was reduced, or approximately?

A. I do not, to give it in terms of electrical units, 2185
but as a fact I think it was not very much reduced, while the quantity, I think, was largely increased.

675 x-Q. Please describe the machine which you had specially made for you while at 94 Walker street?

A. I do not think I could describe it except in a general manner. I should think that it would weigh possibly 1,000 or 1,200 pounds, and from that up to a ton. It had a series of field magnets, I should think, set around a circumference, within which revolve the 2186
armature. It was of the type of machine built by Arnoux & Hochausen for arc electric lighting, but either its winding or connections were such as to give current of less E. M. F. and larger quantity than their ordinary arc electric light machines. It stood about $2\frac{1}{2}$ feet high; was, I think, something over 2 feet in diameter, and 2 to $2\frac{1}{2}$ feet in length. I am speaking of this machine without having seen it, or one like it, for some seven years.

676 x-Q. Can you remember the size of the wires of 2187
the magnets or armature, the nature of the windings and connections, and the E. M. F. of the machine? If so, please state them?

A. I cannot; I can only remember what we did with it.

677 x-Q. I have gone over in detail the various dynamo machines which were used by you in your experiments, and I understand that you are unable to describe these machines in detail, to state in detail the size of the wires with which the magnets or armatures 2188
were wound, or to give in detail in electric units the electro-motive force or quantity of the machines. Am I correct in so understanding?

A. It is true that I cannot describe with accuracy the machine which we used, nor give in detail in regard to them the particulars of which you speak, whether all of the machines which we used have been gone over by you or not.

2189 678 x-Q. What has become of the machine that was bought while you were in Howard street?

A. I think that machine was taken to Ansonia, Conn., by Thos. Wallace.

679 x-Q. I understand that that machine belonged to the Electro Dynamic Light Company. Can you inform me where that machine now is, and under whose control?

A. I do not know, but assume that Mr. Thos. Wallace has it.

2190 681 x-Q. The machine ordered in Centre street I understand to be in your possession at your place in Georgia?

A. It is in my possession at Garnetts, near Dahlonega.

682 x-Q. Do you remember at what velocities the armatures of these machines were driven?

A. The smaller machine was run from 1,600 to 2,000 revolutions per minute; the larger machine from 12 to 1,600 according to the best of my recollection.

2191 683 x-Q. In one of your answers you speak of the arc light machine which was in the basement for a day or two as one that "would light up several lamps of "high resistance, and would send a current through "fine carbon before it had been treated, and its resist-"ance reduced." Is this an inference of your own, or do you mean to be understood that it did do, by actual work, that which you say it could do?

A. I mean to say that it did it, while we were using it there, the work I mentioned. I think that I used
2192 the expression "within a day or two," that may be correct, or it may have been a longer period, as I have several times endeavored to express myself since using the expression.

762 x-Q. What materials did Sawyer and Man try or use as the incandescent conductor for an electric lamp?

Same objection and notice.

A. Carbon, only of different kinds. I have very fully described, as I think, the different carbons we used. Carbons cut out of gas retort carbons, carbons cut out of carbonized, fibrous and textile material, natural and artificial, carbons produced from such materials shaped and sized before carbonization and carbons made from such materials selected to shape and size before carbonization. French carbons prepared and sold in the market of what is usually known as mineral carbon, carbons made by ourselves 2194
from such material, usually called mineral carbons, carbons made by ourselves from various vegetable and animal substances not fibrous or textile; carbons made from lamp black and bone black with admixture of animal and vegetable substances, and not so mixed, carbons made by deposit by the use of an electrical current and a hydro-carbon gas or liquid. All the carbons I have enumerated treated after the manner of our patents for that purpose in a hydro-carbon gas 2195
or liquid, and the same not so treated. I do not now call to mind others, though perhaps there may have been others.

763 x-Q. Then, as I understand you, you tried and used the following classes of carbons for the incandescent conductors of your lamps: non-fibrous, treated and untreated; fibrous, treated and untreated; and carbon obtained by electric action?

Same objection and notice.

A. Yes.

764 x-Q. And I understand of these classes you consider the fibrous carbon the best? 2196

Same objection and notice.

A. I certainly considered the carbon obtained from fibrous or textile material the best. I considered that it was improved by treatment as a conductor for an incandescent electric lamp for general purposes.

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NEW YORK, Oct. 4, 1887, 1 P. M.

Met pursuant to arrangement of counsel.

Present—Counsel as before, and the cross-examination of MR. ALBON MAN was continued, as follows:

898 x-Q. Do you recognize the difference between a carbon which is heated by having a carbon deposited upon it for the purpose of making its resistance conform to a given standard, and the case of a carbon upon which a shell of carbon is deposited, the original
2198 piece or stick of carbon being a core?

A. I recognize no distinction except in the amount of carbon deposited. The process is the same in both cases, and the effect upon the original stick or piece of carbon the same.

899 x-Q. If a given carbon conductor with a given current have a resistance of, say, a hundred and fifty ohms, caused by the carbon being smaller at one point than its general mass, what amount of treatment would be required to reduce the resistance of the carbon to
2199 one hundred and twenty-five ohms, and what effect would such treatment have upon the carbon?

> Objected to on the ground that it is immaterial, there being no question in this case as to high or low resistance, or as to treatment of carbon in the manufacture of illuminating conductors.

A. I do not understand what you mean by "treat-
2200 ment." The question does not contain data sufficient to answer specifically. I can answer the question generally. Shall I do so?

900 x-Q. I understand you to have testified that you in your experiment, used carbons that had not been treated, carbons that had been treated and pencils cut from deposited carbon. By "treated carbons," I refer to such carbons as have deposited upon and in

2201

them carbon. Now, where a pencil of carbon had deposited upon it a layer or shell of deposited carbon, how thick was this layer or shell?

> Same objection.

A. In our work the shell deposited was sometimes almost inappreciable upon the outside of the carbon. As a whole, the main work of deposit being done within the pores of the carbon and at the points of highest resistance in the length of the carbon. In other cases, 2202
and in most cases, it was of extreme tenuity, barely visible upon the outside of the carbon; but in cases where we desired to cut it to pieces after treatment, I think the treatment was carried to the extent of depositing from a thirty-second to a sixty-fourth of an inch, or to one one-hundredth of an inch. The thick deposits were only made by us for the purpose of cutting to pieces lengthwise, or removal of the original slip of carbon on which the deposit was made, as I recollect it now.

901 x-Q. Do you remember testifying in an inter- 2203
ference between Edward Weston and William E. Sawyer and Albon Man, wherein the invention in issue was "the improvement in the art of manufacturing carbon "conductors for incandescent lamps, which consist in "building up on a carbon core or base the body of the "conductor with carbon obtained and deposited upon "the carbon core while surrounded by or saturated "with a carbonaceous liquid?"

> Same objection. 2204

A. I do.

902 x-Q. I call your attention to the 69th question, and your answer thereto, of your deposition in that interference, as follows:

> "R-d Q. 65. Please state whether all the "carbons used by you and your assignees in

2205 "electric lighting by incandescence, so far as "you know, have been treated according to "the process of the inventton involved in this "interference?

"A. They have (and I think I know in re-"gard to all of them), except so far as mere "experiment for testing the quality of carbon "went; we tested in lamps experimentally a "great many kinds of carbon; but for practi-
2206 "cal use, made use only of the carbons treat-"ed according to this invention."

Is your statement in the testimony I have quoted correct?

Same objection.

A. I think my statement is correct. I think we believed, as I do now, that all the carbons were improved by treatment, and so in our practical work we were in
2207 the habit of treating them.

903 x-Q. I call your attention to the following question and answer submitted to and made by you in the Sawyer and Man, Keith and Maxim interference, to which reference has been already made.

"Q. State whether you are one of the parties to the application for a patent by William E. Sawyer and Albon Man for a joint "invention of an improvement in carbons for "electric lighting, making part of the subject
2208 "matter of this interference?

"Same objection.

"I am.

"Q. Please to state what that joint invention is?

"A. The production of a dense, homogeneous, pure carbon by electric action and "the action of heat, by decomposition and

"deposit of carbon from hydro-carbon gases "and fluids. The object being to produce "such carbon for subsequent use, principally "for electric lighting purposes." 2209

In the deposition from which I have quoted, after describing the apparatus used in depositing the carbon and the manner of depositing the same, you say:

"The result was that the slip or pencil of "carbon was heated up to a most intense de- 2210
"gree of heat, decomposition of the hydro-"carbon gas took place, and pure carbon, "very dense and hard and homogeneous, "was deposited upon the slip or pencil of "carbon. After this deposit had gone on "until the slip or pencil became of the size "we desired we ceased the operation, took "out the slip or pencil thus prepared and "used it in an electric lamp. * * * *

"We cut up the carbons so produced and 2211
"took out all the original slips, leaving only "the prepared carbon precipitated or deposited by the action of heat and electricity."

At the conclusion of your deposition you were asked:

"Since you have commenced to treat carbon as you have described, how much of "the time have you used it for electrodes, or "the incandescent parts of your electric 2212
"lamps?"

"A. Constantly. Ever since we first "began."

Is it true that from the beginning of your experiment on treating carbons by deposition, as described in the testimony referred to, up to April 15th, 1879,

2213 you constantly used such carbons as the incandescent parts of your electric lamps?

Same objection; and counsel for defendant is requested to state upon the record how the question or answer is material upon any issue in this case, and upon the further ground that the question contains a garbled statement of the testimony quoted from.

2214 Counsel for defendant makes no response to the request.

A. The interference between Keith and Sawyer and Man, as I recollect it, had reference to deposited carbon; my attention in giving my testimony in that case I assume to have been directed to the point of issue and not to matters not at issue, and my answers in that case are to be taken with this in view. I do not recollect, of course, at this time the words of my answer: I *do* recollect up to the time of this interference we did
2215 use treated carbons as the incandescent conductors of an electric lamp, some with the original carbons on which the deposit was made remaining, and some of pure deposit carbon cut from, or separated from the original carbon on which the deposit was made. I also remember that we used carbon for the incandescent portion of the electric lamp on which no deposit was made, and to which no treatment was given, and also carbons treated only in the slightest degree, and from that to
2216 carbons treated heavily. We were in the habit of generally treating our carbons in some degree. But in this interference the subject matter, as I recollect, was the deposit carbon, and I do not think my attention was directed to the other things that we had done.

904 x-Q. Mr. Sawyer in that interference, was asked and testified as follows:

"Please to state whether, in the practice of "this invection, you build upon the original

"carbon a consolidated pure carbon which "you separate from the original carbons and "use as electrodes in electric lighting? 2217

"A. In some cases we do, and in others we "allow the original carbon and the shell deposited to remain together.

"Q. Please to state how much of the time "you have used this joint invention; since it "was first made?

"A. Hardly a week has passed that we 2218 "have not made a number of these carbons "and used them. We never used anything "else.

"Q. Have you used, or attempted to use in "your electric lamps, carbon pencils of different manufacture, and if yes, please to "state what carbons you have used, or attempted to use?

"A. We have not used anything else in our "regular lamps but the deposit carbon, but 2219 "have experimented with several kinds of willow charcoal, with gas retort carbon and the "best French artificial carbons such as Du "Bosgus, Grandison and Cane, all infinitely "inferior to our invention."

Is it true, as there stated by Mr. Sawyer, that up to April 21st, 1879, the date at which the testimony quoted was given, Sawyer and Man had not used anything else in their regular lamps but the deposit carbon? 2220

Same objection and request repeated. Counsel for defendant is silent.

A. No; and in the alleged testimony you have read Mr. Sawyer does not say so. I understand Mr. Sawyer to say that he used carbons, that is, carbons on which a deposit, more or less, had been made. And he also

2221 said that he has used carbons made wholly from the deposit carbon.

905 x-Q. Do you understand from the testimony quoted, him to say that in your regular lamps none but carbon upon which a shell had been deposited and carbon cut from deposited carbon were used by Sawyer and Man?

Same objection and request; no response.

A. Mr. Sawyer, by the testimony quoted, seems to
2222 have so stated; nevertheless, I think that his statement should be taken, if at all, as made with reference to the question at issue, and that his answer is broader than he intended, and had his attention be called at the time to specific facts and instance, the exceptions would have been made by him in regard to the use of other carbons which actually existed in regular lamps used by us, and I think in answer to the last question quoted, that Mr. Sawyer must be taken as speaking of carbons, not treated, and not of carbons treated, and to
2223 have had in mind our general practice of treating our carbons, and the fact of the issue being the ownership of the invention, deposit of carbon. I think he did not mean deposit carbon, pure and simple, by reason of his previously quoted answer and because of the fact.

906 x-Q. Now, is it true, that in your regular lamps and for practical use, Sawyer and Man used only carbons made from deposit carbons, pure and simple, or carbons which had been treated by depositing carbon
2224 upon them according to the inventions involved in the Sawyer-Man, Keith and Maxim interference, and Weston and Sawyer and Man interference; in the first of said interferences the application of Sawyer and Man, filed November 22, 1878, being involved, and in the

latter the Sawyer and Man patent No. 211,262, the application for which was filed October, 15, 1878? 2225

Objection and request repeated; no response.

A. No, it is not true, the differences being in the understanding of the words "regular" and "practical." To the extent that we preferred, and mainly used, treated carbons in our lamps which we exhibited and used for illuminating purposes in our workships, it is 2226
true, because we thought our carbons were improved by treatment according to the process of these patents and applications; but it is not true, if it were intended to say, that we did not use for illuminating purposes in our workshops or exhibit any lamps in which the carbons had not been treated, nor any deposits made in or upon them, because we did use and did exhibit such lamps with untreated carbons; but we did avoid the exhibiting of such lamps when we had those with 2227
carbons that had been treated, because we preferred the latter; we thought the treated carbons were better; we were in the habit of running all our lamps for lighting our workshops until they gave out.

907 x-Q. The expressions "regular lamps" and "for practical use" are not my terms, but were respectively used by Sawyer and yourself in the testimony quoted. According to your present recollection, is it true that, "except so far as mere experiment for testing the quality of carbon went," all the carbon used by you and your assignees (up to Nov. 22, 1882,) in electric light- 2228
ing by incandescence, so far as you know, have been treated according to the process of the invention involved in this interference—meaning the invention involved in the Weston and Sawyer and Man interference; that "for practical use you made use only of the carbons treated according to that invention"?

Objection and request repeated; no response.

2229 A. In the sense of the matter at issue when that testimony was given, as a general statement and not going into particulars, it would be true, because it was our purpose, finding it advantageous to treat all our carbons, in the sense of the present issue, as to whether we used lamps in which the carbons were not treated, which were practical lamps, if there be such an issue in this case, it would not be true, because we did in running our lamps with carbons before treatment find some that were good. Nevertheless, it was our purpose when
2230 putting up the same kind of carbons in our lamps which we designed for practical use, to have them treated before being put into the lamps.

Defendant's counsel requests Examiner to note that complainant's counsel here says to witness, "would you like to refer to any of those lamp globes?"

A. I have recently refreshed my recollection by reference to old lamps and parts or lamps with tickets
2231 upon them, stating whether the carbons were treated or not treated, used by Sawyer and Man in the fall of 1878, and the winter following, 1879.

908 x-Q. I am anxious simply to ascertain what the fact was. Does your answer to R-d Q. 65 in the Weston, Sawyer and Man interference state what is true?

Objection and request continued; no response.

2232 A. In the sense of that interference I think it is true; so far as the question at issue in that case is concerned, it is true.

909 x-Q. The answers, as I undo.stand you, contain a truthful statement of what the fact really was?

Objection and request continued; no response.

A. It is, but it does not state all the facts, that some of the lamps with carbons not treated were good lamps. 2233

910 x-Q. The fact I am interested in ascertaining is, whether it is true that for practical use you made use only of the carbons treated according to the invention in that interference involved?

Objection and request continued; no response.

A. If you mean by that, that we did not make any lamps which we practically used in which the carbons 2234
were not treated, it is not true, because we did light up our shops in whole or part with lamps in which the carbons were not treated, and they were good lamps, but in the sense that the best lamps that we made, and which were our pattern lamps, and to which we desire to conform the lamps which we should make, these being called our practical lamps and in which the carbons were treated, it is true. In other words, we did not mean to stop with the invention at issue in this case, 2235
but intended, and almost alwas did add to our lamps the invention of treatment.

911 x-Q. At the time of the conclusion of the Sawyer and Man experiments in March, 1879, had Sawyer and Man decided upon a lamp, which could be correctly described as their "regular" lamp, and which they designed for particular use?

A. I think they had upon several.

912 x-Q. Do you mean to be understood that they had not decided on any one lamp, but that they had 2236
several lamps which they considered equally good.

A. They had several lamps which they considered good and practical.

913 x-Q. What I wish to know is whether they had decided upon any one lamp as being the best and the one they intended to introduce for practical use?

A. They had decided upon several different lamps

2237

which they thought were best for use in different places and under different circumstances.

914 x-Q. And had not, as I understand you, determined finally upon any one type or character of lamp?

A. They had, in a certain sense, determined upon one type or character of lamp, that is, the incandescent lamp, for most uses and most purposes; but of this incandescent lamp they had decided that one kind was best for use in one place and for one purpose, and
2238 other kinds for use in other places and for other purposes.

It is proper to add that in addition to this Mr. Sawyer had of himself made up his mind in regard to some arc lamps in which he alone took part, and in a semi-incandescent lamp which he called a feeder lamp, in which I think we both took part, but in regard to which I do not think I had come to a favorable conclusion.

915 x-Q. You have said that when you left Centre
2239 street you had a practical and successful lamp. Had you then decided upon any one type of lamp as your standard lamp, or did you have several standard lamps of different types and constructions?

A. We had several lamps of different types or constructions, all of which we thought were practical lamps. One we considered then the best kind of lamp which we had made, so far as we knew.

916 x-Q. Was there any one type of lamp which you considered best, and which you designed to intro-
2240 duce commercially?

A. Yes, and we also intended to introduce commercially all the types which we considered good.

917 x-Q. You had not then, as I understand, determined upon any one type of lamp, but you had several lamps of different types, all of which you intended to introduce?

A. We had decided upon a type of lamp which we thought would be most useful for most purposes, and

which we considered the best that we had so far made, 2241
and we had decided upon other types of lamps, all incandescent, which we intended to introduce for some purposes and some uses.

918 x-Q. Up to 1882, were any of your lamps used for "practical use?"

A. Yes, a great many of them.

919 x-Q. Did these lamps all have carbons made from deposit carbon, pure and simple, or carbons which had carbon deposited upon them according to 2242
the invention of the patent of Sawyer and Man involved in the Sawyer and Man Weston Interference?

A. No; not all of them, but most of them.

920 x-Q. Then, the broad statement you made in the Sawyer-Man-Weston Interference that for practical use the only carbons used were those of the kind mentioned in my question, was not true, was it?

A. Yes; in the sense of that interference it was true. In practice our carbons were treated; but some of the lamps we used for the illumination of our shop 2243
were not treated. We did not intend to put out for use by others any lamps in which the carbons were not either deposit carbons or carbons treated by deposition according to our invention, but we used for our own illumination and sometimes exhibited lamps in which the carbons were not treated, in othe words we intended to add to our other inventions in regard to carbon for electric lamps the invention in regard to treating the carbons before putting them out for use, and I do not remember that any lamps were put out 2244
in which the carbons were not treated, or of deposit carbon, pure and simple.

Adjourned till Wednesday, the 5th inst., at 4 P. M.

2245

NEW YORK, Oct. 5th, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Albon Man was continued as follows:

921 x-Q. Where we have been speaking of treated carbons or carbons made of deposit carbon, pure and simple, or carbons with carbon deposited on or in them,
2246 do you understand we have been referring to the carbons and the carbons with carbon deposited on or in them referred to and described in the Sawyer-Man Patent, No. 211,262, the application for which was filed October 15, 1878, and which was involved in an interference with Edward Weston and referred to and described in the Sawyer-Man application, filed November 22, 1878, and involved in an interference with Keith and Maxim?

Last objection and request continued. No response.

2247 A. I assume that your reference to patents and applications are correct. If so, yes; I mean carbons produced or improved according to our patents for those purposes.

922 x-Q. Did you consider carbons made from willow charcoal, gas retort carbon, and the best French artificial carbons inferior as incandescent conductors to the deposit carbon or carbons that had carbon deposited on or in them?

2248 Objection and request continued. No response.

A. As to the French carbons and gas retort carbons, yes; as to the carbons made from willow, I do not think so; certainly not after treatment. I am not certain, however, in regard to my recollection of my thought at the time of giving testimony in those cases,

and I may have thought, while testifying, that the de- 2249
posit carbon, pure and simple, was better for an incandescent conductor than the willow carbon alone and before treatment.

923 x-Q. Do you know what Mr. Sawyer's opinion was?

Objection and request continued. No response.

A. I do not recollect, if I knew at the time. 2250

Adjourned till Friday, the 7th inst., at 1 P. M.

NEW YORK, Oct. 7th, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examina- 2251
tion of Mr. Man was continued as follows:

924 x-Q. In the testimony from the Sawyer-Man-Keith-Weston Interference, Mr. Sawyer testified that Sawyer and Man had experimented with several kinds of willow charcoal, with gas retort carbon and the best French artificial carbons, but that all were "infinitely inferior to our invention," referring to carbons made from deposit carbons or carbons which had had carbon deposited upon or in them according to the pro-
cess of your patents.. Do you know, of your own 2252
knowledge, whether such was Mr. Sawyer's opinion?

Question objected to on the ground of incompetency, immateriality, and irrelevancy, and as not cross-examination, there being no question in this case respecting the comparative merits of different kinds of carbon.

Counsel for the plaintiff, or complainant,

2253 requests defendants' counsel to state upon the Record how the question is material upon any issue in the case.

No response from defendant's counsel.

A. I understand Mr. Sawyer, by the word carbon in the testimony spoken of by you, to mean the illuminating conductor of an incandescent electric light. I think I know of my own knowledge that he considered such conductors made from the carbon he men-
2254 tioned without treatment to be inferior to such conductors made of the same material and treated after the manner of our patents. I think, also, I know that as the matter of carbon, referring to its quality for the purposes of an incandescent electric lamp, he considered the quality of the deposit carbon, pure and simple, superior to that of any other carbon, but that at the same time, by reason of the difficulty and expense of making certain kinds of conductor from that carbon, and its liability to fracture, he did not consider the
2255 conductor made wholly of that kind of cardon the best conductor.

925 x-Q. At the conclusion of the Sawyer-Man's experiment, did you and Mr. Sawyer agree as to what was the lamp and type of lamp you intended to introduce?

Same objection.

A. Yes, we agreed as to all the lamps and types of lamps which he intended to introduce except one,
2256 which was what we termed the feeder lamp, which was semi-incandescent and semi-arc lamp; but it is proper to say that in regard to these different types and kinds of lamps, other than a feeder lamp, my views and those of Mr. Sawyer at that time, were not entirely in accordance as to the comparative value of the different lamps which we considered good and intended to introduce.

2257

926 x-Q. Among the patents applied for by Sawyer and Man prior to their separation, I find but two lamps shown and described, and these are the lamps described and shown in Patents No. 205,144 and 210,809; now did you regard the lamps shown and described in these patents as practical incandescent lamps for commercial purposes?

Objected to as incompetent, irrelevant and immaterial.

A. Yes, we did consider them practical for commer- 2258
cial purposes and they were so at the time.

927 x-Q. Did you ever construct any lamps substantially like the lamps shown in these patents?

Same objection.

A. Yes, a great many.

928 x-Q. Do either of these patents represent in substance the type of lamp you have decided upon producing for commercial purposes? 2259

Objected to as immaterial.

A. Yes, they both represent, in whole or in part, types of lamps which we intended to introduce.

929 x-Q. At the time you applied for these patents did you consider the lamps shown in them as the best lamps for commercial purposes that you had made?

Objected to as immaterial

A. I cannot recollect as to the first one; as to both, 2260
we considered them good lamps. As to the second one, I think that at the time of the application for the patent for it, we had made a lamp which in some of its features we considered better than either of these.

930 x-Q. Did you ever apply for a patent for this lamp that you considered better, or show or describe it in any application?

2261 A. Yes, before the application for the patent No. 210,809, which was filed November 5th, 1878, we had presented to Mr. Broadnax (counsel for the Electro-Dynamic Light Company) the features or particulars of a lamp differing from this in some respects, and which we considered better than the one for which we were then applying for patent, or the one which we had previously patented, and asked him to apply for patents for the same. Mr. Broadnax had the subject
2262 before him for this purpose up to the time of the separation of Sawyer and Man in March, 1879, and from that time forward until an application was at last made for these features, or some of them, in the early part of January, 1880.

After the word "yes" the answer is objected to by defendant's counsel.

931 x-Q. Now taking these two patents 205,144 and 210,809, and the application for the patent in suit as
2263 originally filed, did you consider the lamps constructed substantially according to the lamps shown and described in these patents and that application as the best lamps you had made and best adapted for commercial purposes?

Same objection.

A. No; the drawings and description in all these applications do not show the best lamps we made
2264 accurately; they only illustrate the invention sufficiently to obtain the patents for which we were applying.

932 x-Q. Did you intend, and do you think that the two patents as granted and the application for the patent in suit as originally filed, described the lamps sufficiently accurately to enable a person skilled in the art of incandescent lighting as it then existed, or in

the art to which it was most nearly allied, to make and 2265
construct such lamps?

Same objection again as immaterial.

A. Yes, we so intended, and I think the illustrations and description sufficient for that purpose.

933 x-Q. I notice Letters Patent 210,809, refer to Letters Patent 205,144, and state that in Letters Patent 205,144 you "have shown and described an electric "lamp differing not essentially in so far as its main 2266
"features are concerned from that of our present invention," and the object of the invention of Patent 210,809 is stated to be "to produce a lamp more tasteful in appearance and better adapted to afford a successful electric light;" in the application for the patent in suit, as originally filed, the invented is stated as constituting an "improvement upon the apparatus shown in Letters Patent 205,154," now if a person skilled in the art should take these two patents and this application, as originally filed, and construct a 2267
lamp according to the drawings and specifications of the two patents and the application for the patent in suit, as originally filed, would that lamp represent the type of lamp you considered as the best lamp you had made?

Objected to as immaterial and speculative.

A. It would doubtless be of the general type of our best lamps, but would not be the same as our best lamps in all probability unless made by ourselves or 2268
our assistants.

934 x-Q. Did you consider that the size or resistance of the incandescent conductor as being of importance to the construction of the lamp, the arrangement of the lamps, or the kind of generators to be employed?

Same objection.

2269 A. Yes.

935 x-Q. In lamps constructed according to Patent 205,144, what was the resistance of the incandescent conductor?

A. The lowest resistance that I remember in any such conductor was a fraction of an ohm, it seems to me now about one-half an ohm; I cannot recollect the highest resistance; the nearest approximation I can now give was thirty or forty ohms; if they have been higher and could practically have been higher, a con-
2270 ductor for such a lamp could have any resistance between the resistances I have named, or up to a much higher resistance; aand still be operative, if proportioned to the current used.

936 x-Q. You don't answer my question, as it seems to me; what I wish to know is what the resistance of an incandescent conductor would be in a lamp constructed according to Patent 205,144?

Objected to as immaterial.

2271 A. It might be any resistance, if proportioned to the current used.

937 x-Q. What would be the length and diameter of the incandescent conductor of the lamp constructed according to this patent?

A. It might be of any length up to one inch and a half or two inches or longer; its diameter would have to be proportioned to the length in such manner as to give the resistance required for the current used.

938 x-Q. If you considered the resistance of the
2272 conductor, or its length or size as important, why did you make no mention of these things in the patent?

Same objection and request.

A. Because the resistance, length and size are of relative importance only within practical limits, and could be safely left to the electrical expert who should

build lamps to estimate and proportion to the currents 2273
available to them for use; in this answer I am not to be understood as stating anything in regard to the advantages or disadvantages of using currents of higher or lower electro-motive force, but only as speaking of an operative lamp.

939 x-Q. Did you designedly omit in this patent any statement of what the resistance of the incandescent conductor was to be?

Same objection and request. 2274

A. I do not think we had any such design; I suppose we did not think it was necessary.

940 x-Q. Now, turning to Patent 210,809, what would the resistance of the incandescent conductor of a lamp constructed according to this patent be?

Same objection and request.

A. I answer the same as in regard to the previous 2275
lamp.

941 x-Q. Now, take the application for the patent in suit as originally filed, what would the resistance of the incandescent conductor of a lamp constructed in accordance with the description therein contained be?

Same objection and request.

A. It might be anything from the fraction of one ohm up to one hundred and fifty ohms or more, if propor- 2276
tioned to the current available, and be an operative lamp.

942 x-Q. These two patents, and this application, as originally filed, being entirely silent as to what the resistance of the incandescent conductor should be, a person constructing a lamp under these patents and this application would be called upon to exercise his

2277 own judgment as to what the resistance, length and diameter of the conductor should be?

Same objection and request.

A. He would be at liberty to do so, I suppose, in accordance with the currents available to him; he must exercise the knowledge and intelligence of an expert having certain currents available to proportion his resistance to his currents, and also to proportion his conductors or leads to the incandescent portion of his lamp,
2278 so that the resistance of the conductors and leads would be so much less than that of his lamp that the work would be done where he wanted it, to-wit: in the incandescent conductor of the lamp.

943 x-Q. At the time the application for the patent in suit was filed had Sawyer and Man determined upon what the resistance of the incandescent conductor of the lamps shown in the patents and in the application for the patent in suit should be?

2279 Same objection and request.

A. They had not determined upon any fixed or given resistance for their lamps, to the best of my recollection. They had ascertained the advantages and disadvantages of higher and lower resistance in their lamps for the currents which they used.

944 x-Q. Had they determined, at the time of filing the application for the patent in suit, how their lamps were to be arranged, whether in series or multiple arc?

2280 Same objection and request.

A. They had determined that for some purposes and in some places lamps would be used singly and alone; and that in some places and for some purposes they would be arranged in series; in some, in multiple arc; and in some in multiple arc series.

945 x-Q. Had they decided upon any one form of ar-

rangement of lamp as being the best for general commercial purposes? 2281

Same objection and request.

A. I do not remember that we had settled upon any one system to the exclusion of any or all others.

Adjourned till Saturday, the 8th inst., at 1 P. M.

2282

NEW YORK, October 8th, 1887.

Met pursuant to adjournment.

Present—Counsel as before and cross-examination of Mr. Man continued as follows:

946 x-Q. Was it the intention of Sawyer and Man to use the same lamp if arranged in series or in multiple arc?

Same objection and request. 2283

A. That would depend on circumstances and the current available. The same types of lamps.

949 x-Q. You have repeatedly spoken of "currents available," was it your intention to make the lamps conform to such generators as might be possessed, and not to make the generators conform to the character of the lamp?

Same objection and request. 2284

A. It was our intention so make lamps suitable for different currents, and also to make and procure generators or sources of electricity, such as dynamos and batteries, to run a fixed number in each case of particular lamps, the lamps being in each such case of the same kind.

948 x-Q. In your answer to question 944 you say

2285 "Sawyer and Man had not determined upon any fixed or given resistance for their lamps;" had they determined approximately what the resistance of the incandescent conductor should be?

Same objection and request.

A. They had determined what the resistance of lamps should be for different currents and different arrangements of lamps, as these resistances varied in
2286 most cases of actual use; they had not determined or fixed upon one certain resistance for all incandescent electric lamps, either approximately or positively.

949 x-Q. According to the art as it exists, do you know whether it is true that where the lamps are arranged in multiple arc the lamps are of higher resistance, one hundred ohms or more, and where they are arranged in series, they are of low resistance, less than ted ohms?

Same objection and request.

2287

A. No; such is not the fact, without reference to other things which you do not state; a few lamps of low resistance, ten ohms or less, are frequently run in multiple arc; if very many lamps are to be used, or if the lamps are quite distant from the source of the electricity, to be run in multiple arc would require enormous quantity of current and expensive leads or conductors, where the lamps are distant from the source of electricity; for this reason, and for others,
2288 lamps run in multiple arc are of high resistance. This matter is largely a question of distribution of currents and expense and of nothing inherent in the lamp. It is one of those questions of the currents available. Again, lamps run in series, each one in itself a resistance; add resistance to resistance for every lamp added to the series. It is evident that if higher resistance lamps were used, in such cases the total resistance of

2289

a large number of lamps would become enormous, requiring currents of correspondingly high electro-motive force, soon reaching the limit of generators of electricity, or passing beyond control and becoming dangerous. It is evident, therefore, that lamps in series should be of low resistance. This then is a question of currents available, but there is no such general practice as precludes the running lamps of low resistance in multiple arc or the running of lamps of high resistance in series, within the limits of practicability.

950 x-Q. Do you know how, in isolated and central 2290
station plant at the present time, the lamps are arranged?

Same objection and request.

A. I understand that they are usually arranged in series or multiple arc. I am not familiar with the details of recent work.

951 x-Q. Are you familiar with the incandescent lamps that had been patented prior to the labors of 2291
Sawyer and Man?

Same objection and request.

A. I have not them in mind at present.

952 x-Q. Would a lamp constructed under patent 210,809 be of higher resistance than one constructed under patent 205,144?

Same objection and request.

A. Not necessarily; it might be and it might not. 2292

953 x-Q. I understand from your testimony it would depend upon the wish of the person constructing the lamp and upon anything contained in the patents?

Same objections and request.

A. I think largely so; a person could make a lamp of higher or lower resistance of either kind.

2293

954 x-Q. Now take the application for the patent in suit, as it was originally filed. I understand from your testimony that a person constructing a lamp following it and the patents to which it refers, is left in ignorance as to what the resistance of the lamp should be?

Same objection and request.

A. That depends upon whether he is an ignorant
2294 person, or an expert; he is left at liberty to adopt such resistance as he wants.

955 x-Q. Is it now your opinion that at the time letters patent 205,144 were granted, a person skilled in the art could construct a lamp according to that patent and make his lamp either a fraction of an ohm, or forty or fifty ohms resistance?

Same objection and request.

A. Yes.

2295 956 x-Q. What change, if any, would have to be made in the lamp to make it in the one case the fraction of an ohm, and in the other, forty or fifty ohms resistance?

Same objection and request.

A. Simply to make the incandescent conductor of the resistance he required, and adapt the other portions of the lamp to this conductor.

957 x-Q. How could he make the resistance of the
2296 conductor in one case the fraction of an ohm, and in the other forty or fifty ohms?

Same objection and request.

A. By making the conductor of the resistance short and large and of carbon of high conductivity; in the case of high resistance by making the carbons long and small and of carbon of high resistance.

2297

958 x-Q. And this, you think, would be known to a person then skilled in the art?

Same objection and request.

A. Yes.

959 x-Q. Well, what carbons was then known to be of high resistance and what of low?

Same objection and request.

A. The different qualities of French carbons, so 2298
called, were known to electricians to be of less resistance than the ordinary gas retort carbons. They were also known to be of less resistance than charcoal and vegetable carbon. I think the resistances of different carbons were tested by electricians before that time.

960 x-Q. Was it then your opinion that electricians knew that the resistance of the conductor would depend upon its length and cross-section and the kind of 2299
carbon of which it was to be made?

Same objection and request.

A. Yes, it was well known to electricians that increasing the length of a conductor increased its resistance, and that increasing the size or section of a conductor diminished its resistance, and it was known that different carbons had different resistance of same size, section and length, and electricians knew how to test the resistance of carbon and other substances.

961 x-Q. Now I understand you to have made lamps 2300
shown in Patent 205,144, where the resistance of the carbon of such a lamp was the fraction of an ohm. What was the length and cross-section of the incandescent conductor in drawing marked E'?

Same objection and request.

A. I do not know whether I can recollect with accu-

2301 racy the size of those carbons; I can get an approximation. They were less than half an inch in length and more than a twentieth of an inch in cross section; I should say between a twelfth and twentieth; I recollect one of a tenth of an inch cross section.

962 x-Q. Are you answering my question with reference to an incandescent conductor having the resistance of a fraction of an ohm?

Same objection and request.

2302 A. Yes.

963 x-Q. What was the character of the carbon?

Same objection and request.

A. We used several kinds of carbon in those low resistances, some of them French carbons treated and untreated, some of them of deposit carbons pure and simple. I think some of gas retort carbons and some of vegetable fibre carbons, treated and untreated;

2303 with all these carbons it is my recollection we made lamps of less than one ohm resistance.

964 x-Q. Now, if a person wanted to make a lamp under this patent with an incandescent conductor of fifty ohms resistance, what would he have to make the length or cross section of this carbon?

Same objection and request.

A. I cannot tell without knowing the carbon that he was using and its resistance, and then only by experiment.

2304 965 x-Q. Can not you tell me approximately; I understand you have made such lamps with such carbons?

Same objection and request.

A. Yes, we made lamps of forty or fifty ohms resist-

ance. I cannot recollect the size and length of the carbon with accuracy. 2305

966 x-Q. I don't ask you to tell me with accuracy, but approximately?

Same objection and request.

A. From general recollection only, which may be quite inaccurate, my impression is, two inches or more in length and less than a thirty-second of an inch in diameter.

967 x-Q. What was the total length of the conductor between D and *a*? 2306

Same objection and request.

A. I mean by the length I have given, the length of the incandescent portion of the conductor; we did not make all our lamps under that patent with the clamp G, but omitted it in many of the lamps as shown in Fig. 9 of that patent; the length was anything above the clamp G, a small fraction of an inch 2307
would be sufficient, but we used carbons of more than three inches, total length including the incandescent portion and the portion above the clamp G, this total distance from D to *a*.

968 x-Q. Now, this patent describes very minutely the lamp and its construction, and contains a drawing in illustration of the lamp. Do you think that following the patent a person could use an incandescent conductor two inches in length and a thirtieth of an inch cross section in this lamp? 2308

Same objection and request.

A. Yes, I think so, and my recollection is that we did so.

969 x-Q. In your Patent 210,152, applied for October 19th, 1878, you state "we have found that the "internal resistance of a lamp such as that of Letters

2309 "Patent 205,144 is not far from six-tenths of an ohm." Was that statement true?

Same objection and request.

A. Yes, if it was made of that resistance. I do not think that we ever intended to say that it could not be made of higher resistance.

970 x-Q. Now, you are one of the applicants for this patent, can not you give me what the resistance of
2310 a lamp such as is here shown was?

Same objection and request.

A. I could only tell you by measuring it; it you desire to have me state what the ordinary resistances of lamps made by us was, I can tell you or approximate it.

971 x-Q. You cannot then say whether a lamp constructed in strict accordance with this patent would be a high or low resistance lamp?

2311 Same objection and request.

A. I can only say that they might be made of a resistance less than one ohm or of a resistance of forty ohms.

972 x-Q. Equally well?

Same objection and request.

A. There would be more difficulty in making the higher resistance lamp.

2312 973 x-Q. In making the higher resistance lamp, would any alteration have to be made other than in the length, cross section or material of the carbon?

Same objection and request.

A. No, only in proportioning the other parts of the lamp to the carbon used.

974 x-Q. Would the high resistance lamp be as durable as the low resistance lamp? 2313

Same objections and request.

A. Probably not.

975 x-Q. All that you have said concerning the lamp of Patent 205,144, is equally true, as I understand you, of the lamp constructed under Patent 210,809?

Same objection and request. 2314

A. Yes, I think so.

976 x-Q. A lamp under this patent could be made, and, as I understand you, was made of either less than an ohm or more than forty ohms resistance?

Same objection and request.

A. Yes, up to forty ohms.

977 x-Q. Now, did you ever make a completed lamp, such as shown in Patent 205,144? 2315

Same objection and request.

A. Yes, substantially.

978 x-Q. How many completed lamps?

Same objection and request.

A. I do not know.

979 x-Q. Before you left Centre street, how many?

Same objection and request. 2316

A. Several, I don't know how many.

980 x-Q. What is your best recollection?

Same objection and request.

A. My recollection is that we made a considerable number of lamps like that, complete and entire: that we used the same parts of the lamp put in different

2317 conductors into the same globe, modifying the internal works of the lamp and using different conductors in the same lamp or globe a great many times. I cannot say how many.

981 x-Q. What is your best recollection as to the number of lamps substantially like that shown in Patent No. 205,144, you made in Centre street ?

Same objection and request.

A. I have no recollection of it, other than I have
2318 stated.

982 x-Q. Can you not give me any idea whatever whether it was as many as a hundred, or as few as two or three ?

Same objection and request.

A. It was not so few as two or three ; I do not think it was a hundred.

983 x-Q. Do you think it was fifty ?

2319 Same objection and request.

A. I don't know.

984 x-Q. Do you think it was twenty-five ?

Same objection and request.

A. I think it was more than twenty-five.

985 x-Q. As many as thirty, do you think ?

Same objection and request.

2320 A. Yes, I think it was more than fifty, but I don't know ; I mean by this, not separate entire lamps, because the parts were used over and over again.

986 x-Q. What I want to get at is, your best recollection as to the number of separate and entire lamps, as shown in Patent 205,144, were made by, or for, you and Mr. Sawyer while you were at 43 Centre street ?

Same objection and request.

2321

A. That I cannot give you.

987 x-Q. Can you not give me any approximate idea?

Same objection and request.

A. I can guess at it and that is all I can do.

988 x-Q. Can you not state between certain limits ?

Same objection and request.

2322

A. Yes, I can state to the best of my judgment within certain limits, and that is at present, and I might think differently upon calling to mind other circumstances, from fifteen to twenty-five separate and entire lamps of the kind shown in this patent, or similar to it, while we were at 43 Centre street, and perhaps a hundred separate and distinct lamps, counting those in which the parts were used over.

989 x-Q. Now, what is your best recollection as to the number of separate and entire lamps of the kind 2323
shown in Letters Patent 210,809, made by you while at 43 Centre street ?

Same objection and request.

A. I don't remember.

990 x-Q. Tell me your best recollection.

Same objection and request.

A. We made some, I don't remember how many, per- 2324
haps as many as of the other, but I could not say, nor could I say that they were exactly like those shown in that patent ; they were similar.

Adjourned till Monday, the 10th inst., at 1 P. M.

2325

Monday, October 10th, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows:

991 x-Q. Do you mean to be understood, that according to the best recollection at the present time, you made about fifteen to twenty-five separate and entire lamps of the kind shown in Letters Patent 210,809,
2326 while at 43 Centre street?

> Objected to as irrelevant and immaterial and counsel is requested to state upon the Record how this line of examination is either competent or immaterial for cross-examination. No response.

A. While at 43 Centre street, yes; but I mean to be understood, at the same time, that I do not know the number, and that is a mere impression left upon my
2327 mind. It is between eight and nine years since we made them.

992 x-Q. Now, of the kind of lamps shown in Patent 205,144, were the conductors of about the same resistance in these complete and entire lamps?

> Same objection and request; no response.

A. No; I should think not.

993 x-Q. Were they of the same general length and diameter?

2328

> Same objection and request; no response.

A. No; I should think not.

994 x-Q. Do you remember between what limits the resistance varied, and the length and diameter of the conductor varied?

> Same objection and request; no response.

2329

A. No; I do not, to state it with accuracy.

995 x-Q. Do you remember approximately?

> Same objection and request; no response.

A. Yes, I think so; that is to say, I have an impression in regard to it in my mind.

996 x-Q. If you have, state it.

> Same objection and request; no response.

A. The resistance from the fraction of one ohm up 2330
to forty ohms, or possibly fifty or more; the size from less than half an inch in length to two or three inches in length; the diameter from a tenth of an inch or more to a thirty-second of an inch or less.

997 x-Q. As I understand you, you had not determined upon any standard size or resistance for the conductors of these lamps.

> Same objection and request; no response.

A. I have testified fully in regard to that matter. 2331
Your generalization is too large. We had not determined to make any one of the lamps to the exclusion of another.

998 x Q. Well, you did think that the lamp of this patent would be a practical lamp for commercial purposes, with either a comparatively short, thick, low-resistance conductor, or a long, thin, high-resistance conductor?

> Same objection and request; no response.

A. Yes; and we had most urgent requests, or de- 2332
mands, to sell lamps of both kinds.

999 x-Q. What we have been saying of the lamp under 205,144 is equally true of the lamps under 210,809?

> Same objection and request; no response.

2333
A. Yes.

1000 x-Q. Now, while you were at 43 Centre street, did you make any lamps in which the conductor was of paper, or carbonized fibrous or textile material?

A. Yes.

1001 x-Q. About how many complete and entire lamps were made, having such conductors, at 43 Centre street?

A. That I can't say.

2334 1002 x-Q. According to your best recollection, about how many?

A. I have no distinct recollection in regard to the number. I have no record of them, and as we continually used over the parts of lamps with different carbons substituted in the same lamp, I do not think I could even approximate the number.

1003 x-Q. Can you give me no idea?

A. No, I can't, for the reason that we so often changed our lamps, and changed the internal works
2335 and carbons, using the same globes or glass envelope, that I cannot distinguish one from another.

1004 x-Q. Can you not give me some idea, whether as many as a hundred or as few as two?

A. We made more than two separate, distinct and complete lamps, and less than one hundred, in which this kind of carbon was employed.

1005 x-Q. Were as many as ten separate and distinct lamps in which this kind of carbon was employed made at 43 Centre street?

2336 A. I cannot tell.

1006 x-Q. As many as twenty?

A. Same answer.

1007 x-Q. As many as fifty

A. Same answer.

1008 x-Q. As many as seventy-five?

A. I should think not.

1009 x-Q. As many as sixty?

2337
A. I should think not.

1010 x-Q. As many as fifty?

A. I think not, but I can't tell.

1011 x-Q. As many as forty?

A. Same answer.

1012 x-Q. As many as twenty?

A. I will tell you simply what I think, and my impression is based upon a review in my own mind of the work we did at Centre street. I think we set up 2338
one or two complete sets of lamps, in which the vegetable fibre carbon was employed, and in which the parts of the lamps had not been used with any other carbons. The sets were composed of from eight to twelve lamps. Now, I may be mistaken in regard to all the parts of these lamps not having been used with other carbons, and it may be that we set up more entirely distinct lamps with these carbons, or less. I think we set up and ran of all kinds of lamps with these carbons, in the neighborhood of fifty to a hundred lamps. It may have been more and may have 2339
been less, while we were at 43 Centre street.

1013 x-Q. Are you confident that as many as ten lamps were run to incandescence in Centre street, which lamps had conductors of fibrous or textile material?

A. Yes, very many more than that; from fifty to a hundred.

1014 x-Q. Do you remember the first completed lamp made by you in Centre street which had a conductor of this kind? 2340

A. No, I do not, as a separate and distinct lamp. I remember the form of the globe in which we first used conductors of that kind.

1015 x-Q. Do you remember the first attempt to run to incandescence a conductor of carbonized fibrous or textile material was, whether in what might be called a lamp or in rude experimental apparatus?

2341 A. I do remember it.

1016 x-Q. Now, please to state what the first experiment was which you and Mr. Sawyer conducted at 43 Centre street on running to incandescence a conductor of carbonized fibrous or textile material?

A. It was an attempt to pass the current through a piece of paper on Mr. Sawyer's desk.

1017 x-Q. What kind of paper?

A. My impression is that it was a piece of blotting paper.

2342 1018 x-Q. Had it been carbonized?

A. No.

1019 x-Q. What was its size and shape?

A. I should think about an eighth of an inch wide, more or less, and a couple of inches long, a long, narrow slip cut from a sheet of ordinary blotting paper.

1020 x-Q. How did you connect your conductors with this blotting paper?

A. It lay upon the table and we put the terminals down upon the paper as it lay there.

2343 1021 x-Q. Well, what happened?

A. Nothing, no current passed.

1022 x-Q. Was the paper injured?

A. No, sir.

1023 x-Q. What was your object in trying this experiment?

A. I forgot what we had in view at the moment.

1024 x-Q. What information did you derive from it after it had been tried?

A. That the paper formed a good electrical resist-
2344 ance or insulator.

1025 x-Q. Didn't you know that before?

A. No, we did not know how good that particular kind of paper would be as an insulator.

1026 x-Q. Did you know what the electro-motive force of your generator was at that time?

A. I don't think we did.

1027 x-Q. Did you know about what it was? 2345

A. No, I don't think we did; only that it was a considerable number of volts.

1028 x-Q. About how many?

A. I don't reccollect that we thought of it at the time.

1029 x-Q. Which of the dynamos that you had in Centre street were you using at this time?

A. I think the one in the basement, an arc lighting dynamo.

1030 x-Q. Do you remember what the next thing 2346
that was done by you and Mr. Sawyer at 43 Centre street was, in relation to the use of fibrous or textile material as an incandescent conductor?

A. Yes.

1031 x-Q. Please state?

A. We next drew a fine line with a piece of graphite on this same slip of paper or a similar one, put a little pile of graphite at each end of the line, pressed it down and placed the electrical terminals on the piles 2347
and endeavored to pass the current through it. Not succeeding, we increased the size of the line and approached the pile of graphic to each other at the extremities until the current finally passed along the line. We had made by repeating markings an indentation on the line which we filled up with graphite, increasing the size of the lines, and pressed it down. The current passed by a series of sparks along the line of graphite and the paper was burned along the line, and charred through to the under side of it. 2348

1032 x-Q. With reference to the time of the first experiment, when was this done?

A. Immediately afterward, following at the same moment contionously.

1033 x-Q. What was your object in trying this experiment?

A. Mr. Sawyer had a theory somewhat similar to Mr. Edison's as I have understood it, that a very high

2349 electrical resistance in the incandescent conductor would be highly advantageous and he was endeavoring to illustrate to me the effect of such a resistance by this crude experiment, and that was the object of the experiment.

1034 x-Q. I do not understand your answer. How did this experiment illustrate anything?

A. Mr. Sawyer said that if we could get a conductor that would stand the "racket" as he called it, as fine as a hair or the smallest pencil line, it would be per-
2350 fection for a conductor. I said to him that we could not get a current through it with my electro-motive force we had available or that would be safe. He insisted that it could be done and this led to the experiment.

1035 x-Q. Did you say what kind of a conductor?

A. I don't remember.

1036 x-Q. Was this experiment then merely to ascertain the electro-motive force of the machine?

2351 A. No, it was to demonstrate that with the electromotive force we had available and which was safe to use, we could send a current of sufficient strength through a very high resistance to heat it up to incandescence.

1037 x-Q. Did you expect to run this paper up to incandescence?

A. No, sir; Mr. Sawyer expected to run the plumbago up to incandescence.

1038 x-Q. Did he or you think that the first fine pen-
2352 cil line you made would become incandescent?

A. I don't know.

1039 x-Q Now, as I understand, you kept adding plumbago to the paper and shortening the length of the line until you could get a current through; is that correct?

A. Yes.

1040 x-Q. Did you or he expect that when you

reached a point where the current would pass through the plumbago it would become incandescent? 2353

A. Yes.

1041 x-Q. What part did the paper play in this experiment, and would not any insulating substance, such as rubber, have answered the same purpose?

A. I think it would; the paper was a convenient article.

1042 x-Q. Was there then no special object in using the paper, other then as an insulating holder for the 2354
plumbago?

A. That was all.

1043 x-Q. Did this experiment inform you of anything or suggest anything?

A. Yes.

1044 x-Q. What?

A. It gave us some knowledge of the conductivity of the plumbago we were using, and we proceeded immediately to further experiments.

1045 x-Q. Was this the only suggestion or informa- 2355
tion you derived from this experiment?

A. Yes, I believe so. I don't recollect anything else.

1046 x-Q. How could you have learned of the conductivity of the plumbago you were using, without knowing the electro-motive force of your machine and the exact amount of plumbago placed upon the paper?

A. The only information we obtained was relative and not positive; we found that we could pass the current from that dynamo through a certain length and size of packed plumbago.

1047 x-Q. What now was the next thing that you 2356
did?

A. The paper being charred and burned in the last experiment and the line of plumbago broken so as to break electrical connection, we took a slip of paper, soft and porus, filled it with plumbago to the best extent we could, rubbed it with plumbago in a groove in

2357 a piece of iron with a burnisher, pressed it, put it on the desk with a sheet of mica underneath it and applied the electrical terminals.

1048 x-Q. What was your object in this?

A. We thought, in that way, possibly we might demonstrate what Mr. Sawyer had said in regard to high resistance, and that there was less liability of the breaking of the conductor and that we would continue to pass a current through it a longer time before it would be destroyed.

2358 1049 x-Q. What had Mr. Sawyer said in reference to high resistance that you expected this experiment would demonstrate?

A. I have already stated that before. I will repeat it if you desire; as I said, Mr. Sawyer had a theory that a very high resistance conductor of small section, even as small as a hair or a pencil mark would be highly advantageous if the conductor could be made to endure; on the other hand, I said that I did not think that such very high resistance would be advan-
2359 tageous and stated that no electro-motive force available to us or that would be safe would pass a current of sufficient strength through such a conductor to make it incandescent; Mr. Sawyer contended to the contrary of my views and that a current could be passed through such a conductor to make it incandescent from the dynamo we were then using.

1050 x-Q. Now you could not have expected that this experiment could show anything in regard to the durability of such a conductor. I, therefore, infer that
2360 the object was to ascertain whether your machine would drive a current through it; am I correct?

A. Yes, a current of sufficient strength to make it incandescent.

1051 x-Q. In this experiment, as in the former was the paper used simply as a vehicle to hold the graphite?

A. Yes, as a holder of the graphite. 2361

1052 x-Q. What information or suggestion did you gather from this experiment?

A. The conductor remained incandescent longer than we had anticipated, and when it finally broke, and broke the electrical connection, portions of the paper, charred and condensed, were left upon the mica, took fire and slowly burned up; we were in trouble about getting carbons for incandescent conductors and the thought occurred to both of us that we had possibly hit upon a way in which such carbons could be pro- 2362
duced of the size and shape and resistance which we desired, if we could prevent the consumption of the paper; we therefore at once proceeded to further experiments.

1053 x-Q. In order that there may be no misunderstanding, had you at this time determined upon what size, shape and resistance of incandescent conductor you desired?

A. Only tentatively; we had been making conductors out of French carbons in straight pencils, working 2363
down the pencils to get them small; we had also been making carbons out of thin sheets of French carbon which we formed into an arch to rise above the holders of the lamps; we had great difficulty in working down these carbons to size and shape such as we were then trying to use.

1054 x-Q. I do not understand from your answer whether you had or had not determined what the size, shape and resistance of the incandescent conductor should be? 2364

A. I have answered your question, it seems to me, as fully as I can; perhaps I should add that we were endeavoring to make our conductors as small as possible in section in accordance with Mr. Sawyer's theory of the advantages of high resistance; we certainly had not determined on any fixed resistance or any fixed size

2365 of conductor, and we were trying different shapes of conductors.

1055 x-Q. Am I then to understand that you saw in this way a possibility of overcoming the mechanical difficulty of getting a carbon of small size and of any desired shape?

A. Yes, that is what I mean to be understood; that is, we would avoid the difficult operation of shaping carbons, and sizing them, by shaping and sizing the
2366 material from which they were made.

1056 x-Q. Now at the time of these experiments, for I understand they were all on the same day, had you as yet made what you would call a lamp; I do not refer to rude experimental apparatus, such as chemical flasks with improvised holders and carbons, but a lamp mechanically constructed.

A. I say yes. We had before then made some lamps, which, considering their cheapness and practicability, would be useful to-day, if the present im-
2367 proved lamps could not be obtained and in places where those lamps were not at hand for use.

1057 x-Q. If then you had at this time made lamps as you say, in view of your statement that you then "were in trouble about getting carbons for incandescent conductors," and "had been making conductors out of French carbons in straight pencils, working down the pencils to get them small," and "had also been making carbons out of thin sheets of French carbon," I infer that these experiments must have been
2368 made some time after you had been at work in Centre street. Am I correct?

A. We had been there for a little time, I cannot now remember how long, but it was after we had set up and tried a good many lamps.

1058 x-Q. Now let me recall your attention to the fact that you did not go to Centre street until the 7th of March, 1878, that no experiments had been conducted before you went to Centre street except the one

at the Coal and Iron Exchange. Then when you went 2369
to Centre street you had no facilities, apparatus or tools for experimentation, but had to get them, that your working force in Centre street was limited to Sawyers, the elder and junior, to Kaeting and Sharp, that the working down of carbons or the making of lamps must have taken considerable time, and that the lighting machine which you say you used was in the basement of the building, and, if you remember, was only open to your use for a day or two after you went to 2370
Centre street. I call your attention to these facts with the view of refreshing your recollection as to the time of these experiments, for it seems to me that if the experiments which your answers would imply had been conducted, these particular experiments must have been made at a comparatively late day, or if they were performed immediately on your arrival they could not have been preceded by the amount of work your answers import?

A. In answering at this day in regard to events tak- 2371
ing place between eight and nine years since, I cannot hope to reach positive accuracy. My recollection accords with yours in regard to all the matters testified to, except the length of time during which Arnoux & Hochausen's lighting machine was in the basement. I think it was certainly while that machine was there that we tried the experiments I have related, and reviewing the subject in my own mind I cannot fix the time of these experiments within a few days after our going to Centre street, and before making these experi- 2372
ments we had certainly made a large number of conductors from the French carbon, and experienced the difficulty of which I spoke in their manufacture, and had exhausted, as I think now, all the stock of that kind of carbon, or nearly all, that we could get hold of. Therefore, I think that it was the fact that before these experiments we had made the lamps of which I have spoken. From other circumstances, it seems to me

2373 that these experiments took place soon after the agreement of the 19th of March, between Mr. Sawyer and myself. It may be that I am wrong in regard to the time of the arc light machine being there, or it may have been that Arnoux & Hochausen, who were continually experimenting, took out the first machine and were experimenting with another one, or, they may have cut us off from the use of that machine for a while and then subsequently we used it, or it is barely possible, though I think it highly improbable, that these
2374 experiments took place earlier than I think.

Adjourned till Tuesday, 11th inst, at 1 P. M.

TUESDAY, OCT. 11th, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows:

Witness says: I wish in this connection to call atten-
2375 tion to my answers to cross-question 332 and cross-questions following to 400, in which it will appear that I had not endeavored to fix with any certainty the time during which the arc lighting machine remained in the basement.

1059 x-Q. Are you positive, however, that it was while the arc lighting machine was in the basement and you had a current from it, that these experiments were performed.

A. No.

2376 1060 x-Q. Are you positive that prior to the conduct of these particular experiments you had been making the carbons mentioned in your 1055th answer and had made lamps as stated in your 1058th answer?

A. I am as positive in regard to the carbons as I can be at this length of time and I am confident, but not positive, as to the lamps. It seems to me that I can-

2377

not be mistaken in regard to it, nevertheless, it is too long a time since then, unless some positive fact in regard to which the date could be definitely fixed should be brought to my attention, that I should be absolutely positive.

1061 x-Q. Can you remember what the first lamp was which was made in Centre St. By "lamp" I do not mean rude experimental apparatus, such as chemical flasks or a globe with improvised carbon supports and stoppers, but a mechanically and completely construct- 2378
ed lamp?

A. I do not recollect any one in particular, but of types of lamps I recollect the earlier or first ones. The globes were made of Florence flasks. The second kind, as I recollect it, were globes like Florence flasks with wider mouths and flanges which I got blown at the glass factory.

1062 x-Q. I want to make myself clearly understood. I assume that at some time there was made in Centre street a lamp complete and mechanically constructed. 2379
If such a lamp was made, I assume it must have been made by some one, proper tools must have been employed, and as the making of this lamp must have necessitated the construction of special parts, few of which existed in trade, and most of which must have been specially constructed, which parts must afterwards have been put together, and the lamp must have been either exhausted or charged, the entire work being done, I assume, under intelligent direction; more- 2380
over, for the making of these parts instructions, drawings, and the like, must have been given. Now, do you not remember whether such a lamp was made, what its character and construction was, and by whom and where it was made?

A. The difficulty of your question is that you do not distinguish by proper words what you mean. The first lamps we made or caused to be made during the

2381 first week we were in Centre street answered the description you give. They were intelligently planned by Mr. Sawyer and myself. We procured the glasses and caused the metal parts to be mechanically made; caused them to be set up or set them up ourselves, and run. From that time forward, we made other and different lamps continuously, which answer your description, up to the time when we left 43 Centre street in May or June. I cannot distinguish or tell the time, nor positively describe with accuracy the different
2382 kinds of lamps nor the time of their production. You will see them pictured, or some of them, rudely, in the testimony of Mr. Church and possbly of Mr. Sawyer in the interference case. You have endeavored in this case to obtain an acquiescence from me, in the limiting of the number of persons engaged on the work of the lamps or their construction in parts, to certain persons you have named, omitting all work done out of the shop by other parties, of which a large amount was done by different parties.

2383 Answer objected to as irresponsive.

1063 x-Q. I am anxious to learn the facts in regard to the making of lamps in Centre street, by whom they were made, what their constructions were, where they were made, or your best recollection in regard to these things. Now, I have endeavored to explain what I meant by a lamp, and I shall endeavor to make myself clear. A Florence flask filled with an inert gas, with an improvised stopper, with rude conductors and
2384 carbon, I do not understand to be anything but experimental apparatus. A lamp could not have been a simple thing to make. The question of globe, base, holders for the carbon, connection of the carbon to the holders, adaptability for charging or exhausting, must have all entered into the construction of a lamp. If, in point of fact, such a lamp was made in Centre

street, the first lamp, or if more than one were made, 2385
set of lamps, must have been the subject of discussion and explanation. Now, can you not remember the circumstances surrounding the making of such a lamp, or set of lamps, what its general character was, and what its parts were?

A. The very first lamps we made in Centre street with Florence flasks for globes answer your description of a lamp. They were intelligently planned for lamps, their parts adapted for all the purposes of which you 2386
speak, and more. They were lighted up and run as lamps. In answer to your desire expressed in the first part of your question, their parts were gathered together by purchase of the glasses, manufacture of the bases, cast and worked up at places and nicely finished with conductors insulated through the bases by appropriate insulation, with platinum tips for the holders of the carbon, and with an inert or carbon preservative gas as an atmosphere; part of the work being done by 2387
jewelers, part by instrument makers, part in our own shops, part by Mr. Keating, part by Mr. Sharp, perhaps (I don't recollect whether he was there at first), and very probably parts by other parties, assembled and put together in our shop, or in Mr. Sharp's place in Brooklyn, the whole being run, by Mr. Sawyer and myself, as electric lights, from that time forward; lamps, each perhaps an improvement in some particulars upon the other, that had gone before it, were certainly made by and for us while at 43 Centre street, until we reached lamps that were satisfactory to us for the 2388
time being. Now, I have to say that I cannot give the time of any of these steps with any considerable degree of accuracy. I can give you the impression that remains in my mind, as to the time when we got lamps that were satisfactory to me and that I considered practical lamps.

Answer objected to as irresponsive.

2389 1064 x-Q. As near as you can now recollect you went to Centre street on the 7th of March, did you not?

A. 6th or 7th of March.

1065 x-Q. Do you bear in mind your testimony in regard to the fitting up of the rooms?

A. Generally; not in particular.

1066 x-Q. Do you remember the first time in 43 Centre street you ran a conductor to incandescence, the conductor being in a glass globe of some kind?

A. Yes.

2390 1067 x-Q. Do you remember generally what the conductor was, what the globe was, and how the conductor was placed upon the conducting wires?

A. Yes.

1068 x-Q. You say you remember; now tell me what the incandescent conductor was; what the globe was and how the incandescent conductor was fastened to the wires?

A. The incandescent conductor was a pencil of gas retort carbon or of French carbon; the glass was a
2391 Florence flask. The incandescent conductor was held between two metal supports in depressions made in the support by the pressure of the support against the ends of the conductor?

1069 x-Q. Please make a drawing illustrative of the apparatus you have just described?

(Witness makes a sketch.) Same offered in evidence and marked Defendants' Exhibit "Man Sketch, October, 11th, 1887."

2392 1070 x-Q. What was the atmosphere in the flask?

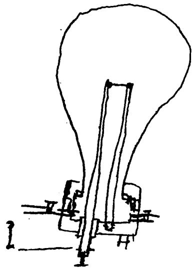
A. Ordinary illuminating gas.

1071 x-Q. Who constructed this apparatus?

A. I don't recollect.

1072 x-Q. Was it constructed in your presence?

A. It was put together in my presence and Mr. Sawyer and I together bought the flasks.



1073 x-Q. What was the base of this apparatus? 2393
A. It was of cast brass, one ring cemented to the
Florence flask, and the other screwed upon that with
an insulation through the base for one of the holders.
1074 x-Q. There appears to be two holders. Please
state how these holders passed through or were attached to the base?

A. One of the holders was simply screwed down into
the bottom of the base or cup on the inside; the other
passed through a piece of hard rubber, screwed into
the base and thus insulated from it, terminating 2394
in a binding screw. The other binding screw was fastened to the outside of the base. There were orifices
in the base, with stopcocks for passing the gas in and
out of the lamp in charging it.

1075 x-Q. Now, who made this base with its binding
posts and stopcocks?

A. I don't know. Mr. Sawyer got it done. I presume I knew at the time.

1076 x-Q. Who furnished the instructions by which
the mechanic made this base and its parts? 2395

A. Mr. Sawyer had talked it over, made some rude
sketches, Saywer made more perfect ones, gave the instructions and employed the people to do the work.

1077 x-Q. How long after the mechanic had
the drawings, &c., did it take before the base and
parts were delivered to you?

A. I don't know. It was done before we went to
Centre street.

1078 x-Q. About how long do you think it took to
make? 2396

A. I have no recollection definitely.

1079 x-Q. Well, with reference to the 6th or 7th of
March, the time you went to Centre street, when was
this base delivered to you and Mr. Sawyer?

A. Well, I think Mr. Sawyer had them. They had
been delivered to him before we went to Centre street,

2397
or the evening before. A day or two before that, I bought the platinum for facing the holders.

1080 x-Q. You say "them;" was more than one base and its parts ordered?

A. There were six or eight of them.

1081 x-Q. The same in design and construction?

A. Yes, nearly, if not quite.

1082 x-Q. If they differed at all, do you now remember what the difference was?

2398 A. Some one or two of these bases were not like the rest and were, I think, got up by old Mr. Sawyer; whether they were in addition to the six or eight that Mr. Wm. E. Sawyer got manufactured, or a part of them, I can't recollect.

1083 x-Q. You don't tell me that for which I inquire, to wit: the point of difference?

A. That I don't recollect. I don't know they *were* different.

1084 x-Q. You don't remember who made them; do
2399 you remember who paid for them?

A. Yes, I paid for them, or gave the money to Mr. Sawyer to do so.

1085 x-Q. Well, which was it?

A. My impression is that I gave him the money to pay for them.

1086 x-Q. Now, have you any check, voucher, bill or memorandum of any kind that would show who made these bases and their parts, or which would aid you in remembering who made them?

2400 A. No, sir.

1087 x-Q. You have spoken of platinum for facing the holders in your 1079th answer, which you say you bought; where did you buy it?

A. I don't recollect.

1088 x-Q. Now, platinum is not on sale everywhere and not an easy thing to purchase; does nothing occur to you that would enable you to remember where you bought it?

A. No; and, on the contrary, it is an easy thing to 2401
purchase; it may be bought of almost any dealer in precious metals, and at almost any jeweler's shop.

1089 x-Q. Have you ever bought any before?

A. Yes.

1090 x-Q. More than one?

A. Yes, I think so.

1091 x-Q. Do you remember where you bought it?

A. No.

1092 x-Q. Do you remember whether you bought 2402
the platinum for facing the holders at the same place as you had bought the platinum previously?

A. No, I do not recollect.

1093 x-Q. Did you buy it in New York or Brooklyn?

A. I think I bought it in New York, but I don't recollect.

1094 x-Q. Did you buy it personally or send some-one for it?

A. I bought it personally.

1095 x-Q. Was it delivered to you personally at the 2403
place where you bought it, or was it sent to you?

A. It was delivered to me personally at the place where I bought it, and I gave it to Mr. Sawyer.

1096 x-Q. Do you remember what you paid for it?

A. I do not.

1097 x-Q. Can't you tell me about how much?

A. I cannot.

1098 x-Q. How much did you buy?

A. That I don't recollect.

1099 x-Q. Can't you tell about how much? 2401

A. No.

1100 x-Q. Can't you give me any idea whatever as to how much you bought and how much you paid for it?

A. No, only that it was a very small quantity.

1101 x-Q. Well, did you pay as much as a thousand dollars or as little as ten dollars for it?

A. I did not pay either sum.

2405 1102 x-Q. Do you think it was less than ten, or more?

A. If you ask my judgment of the amount I will give it to you.

1103 x-Q. Well, do so.

A. I should think two, three, or four dollars, possibly five.

1104 x-Q. What kind of store did you buy it in?

A. I don't recollect where I bought it; probably at a goldsmith's, or goldsmith supplies.

2406 1105 x-Q. Now, I understand you are positive that these metal bases and their parts were delivered before you went to Centre street, or on the first day you were there?

A. Yes, I think the day before; perhaps not all of them the day before.

1106 x-Q. What use was made of the platinum in these bases and their parts?

A. It was not used on the bases; it was cut up into small pieces, a little less than an eighth of an inch
2407 square or round, brazed to the inside face of the holders at their top end, and a small hole drilled or punched not quite through the platinum, to receive the ends of the carbon conductors.

1107 x-Q. Who did this work—the mechanic that made the bases?

A. No; I do not know the individual who did it, but some jeweler brazed the pieces to the copper holders.

1108 x-Q. Who was the jeweler?

A. I don't know; Mr. Sawyer got it done.

2408 1109 x-Q. Were the holders taken to the jeweler before the entire base was made, or afterwards?

A. I do not know; it was probably after they were fitted to the bases.

1110 x-Q. Did you ever see the jeweler, or give him any instruction?

A. No, sir.

1111 x-Q. Who paid the jeweler? 2409

A. I paid out for all the work.

1112 x-Q. Now, have you any bill, check, voucher or memorandum that would either enable you to state who the jeweler was, or refresh your recollection as to who he, the jeweler, was, or refresh your recollection as to who he was?

A. I have lost my memoranda of those payments, or mislaid them so that I cannot find them.

1113 x-Q. Do you remember about what the bases 2410
and holders cost?

A. I do not.

1114 x-Q. Now, I understand it was with these bases and holders, and with a Florence flask as a globe, that you ran your first conductor to incandescence in Centre street; am I right?

A. Yes.

1115 x-Q. How long was it before you either had made, or made other bases or holders than these?

A. I cannot recollect, but it was within a week, I 2411
think.

1116 x-Q. Then you think you used these, and only these, during the first week you were in Centre street?

A. No.

1117 x-Q. Defendant's Exhibit Man Sketch shows a distinct type of apparatus with very carefully prepared base and holders, and this, I understand, was the first apparatus you used. Now, when did the first modification of, or departure from this apparatus take 2412
place, and what was the modification and departure?

A. Instead of the Florence flask we used a straight glass tube with a metal cap at either end, the conductors screwed into the metal caps on the inside, the caps cemented to the tube and the incandescent conductors extending from the end of one holder to the end of another.

2413 1118 x-Q. Please illustrate by a sketch ?

(Witness makes a sketch.) Same offered in evidence and marked Defendant's Exhibit Man Sketch No. 2, Oct. 11, 1887.

Adjourned till Wednesday, 12th inst., at 1 P. M.

Wednesday, Oct. 12th, 1887.

2414. Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination Mr. Man proceeded as follows :

1118½ x-Q. In this sketch No. 2, how was the incandescent conductor attached to its supports ?

A. It was stuck into one end of one support and the other support was pressed up against the other end, small holes or depressions being made in the ends of the supports to receive the ends of the carbons.

2415 1119 x-Q. Were the brass caps used in this second apparatus, parts of the brass bases to which you have referred, or were they made specially for this second apparatus ?

A. I think they were made specially.

1120 x-Q. When were they made—before you went to Centre street, or after ?

A. I think afterwards.

1121 x-Q. Were they colored afterwards or before ?

A. I cannot say.

2416 1122 x-Q. Were they ordered after the first apparatus had been tried ?

A. My impression is they were. I cannot positively say.

1123 x-Q. Is it then your best belief that they were ordered after the Exhibit No. 1 had been tried ?

A. Yes.

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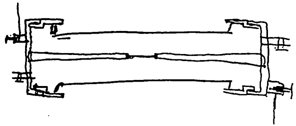
NEW YORK

Especial attention given to the Law of Patents.

AMOS BROADNAX,
J. EDGAR BULL.



Defendant's exhibit
Man Sketch no 2
Oct 11 1887

2417

1124 x-Q. In the apparatus shown in Exhibit No. 1, did you try other atmosphere than illuminating gas?

A. Yes.

1125 x-Q. Did you try a vacuum?

A. My impression is that we did; I am not positive.

1126 x-Q. Was it after you had experimented with the apparatus of Exhibit No. 1, employing as its atmosphere something other than illuminating gas for exhausting chamber, that you ordered the parts for apparatus No. 2? 2418

A. No, I should think not.

1127 x-Q. Do you think that the parts for Exhibit No. 2 were ordered before you had tried the apparatus of Exhibit No. 1 with an atmosphere other than illuminating gas?

A. Yes, I think they were.

1128 x-Q. What was the object, or what suggested the making of this apparatus in Exhibit No. 2?

A. I have no recollection, but from the difference between the two apparatus, it is evident that the second 2419
apparatus was made to avoid any isolation of the leads and conductors other than the glass of the tube or globe.

All after "recollection" defendant's counsel will move to strike out as incompetent.

1129 x-Q. I understand you, then, to argue that the object of making this second apparatus, as you state, was that you have no recollection now as to why you made it? 2420

A. I make no argument upon the matter. I simply state that the apparatus itself shows the object sought in its construction.

1130 x-Q. The trouble is we have not got the apparatus; I understand you to remember what the apparatus was, but to have entirely forgotten why you made it?

2421

A. My sketch shows the apparatus, and illustrates the point of avoidance of insulation of the conductors, or either of them, by any means other than the glass tube or globe.

1131 x-Q. And you therefore think this must have been its sole object, and you now have no recollection of its having been made for any other purpose?

A. That, I think, is correct.

1132 x-Q. Who made the brass caps and holders for
2422 this apparatus?

A. That I don't know.

1133 x-Q. Were they made in the shop No. 43 Centre street?

A. No, I think not.

1134 x-Q. Have you no recollection whatever as to who made them, or where they were made?

A. No.

1135 x-Q. Who gave the order or instructions to the mechanic who made them?

2423 A. I believe Mr. Sawyer did.

1136 x-Q. Who paid for them?

A. I paid for everything.

1137 x-Q. Did you pay directly or give Sawyer the money?

A. I don't know. The manner of payment of things was, either to hand Mr. Sawyer the money when he showed me the bills, or to send the money by a messenger with the bills to make payment. Sometimes and frequently Mr. Sawyer paid bills as the things were
2424 sent into the shop, made memorandum of the payments he made, and afterwards I gave him the money for them.

1138 x-Q. Have you any voucher, paper, receipt, check, or anything that would show or aid you in remembering by whom or where the caps and holders of the apparatus shown in this exhibit were made?

A. No.

1139 x-Q. Did these holders have platinum tips? 2425

A. I think they did, but I am not certain.

1140 x-Q. The holders used in this apparatus were not, or were they, the holders of the first apparatus altered.

A. They were not, I think.

1141 x-Q. Who made the holders and put the platinum tips upon them?

A. I don't know; my impression is they were made at the shop.

1142 x-Q. Now, as the caps and holders had to be 2426
specially made from drawings or instructions, can you tell me how long it was after they were ordered before they were delivered?

A. No; a very short time, however.

1143 x-Q. When you say "a very short time," what do you mean?

A. A day or two; or two or three days.

1144 x-Q. When did you get the glass tubes that were used in this exhibit? 2427

A. My recollection is that it was a piece of a large glass tube about an inch and a quarter in diameter, which I had at my house; we cut it into two pieces I think, at the shop.

1145 x-Q. The cap must have been made with reference to the the size of the tubes, must it not?

A. Yes; I think they were.

1146 x-Q. Was more than one apparatus of this kind made, or did you order the parts for more than one?

A. Yes; we had two sets, but I do not think we ever used or set up but one. 2428

1147 x-Q. What was the next departure or modification in the way of apparatus in which a conductor was run to incandescence?

A. I cannot pretend at this time to give the order with exactness in which different things were done. I remember getting from Haggerty Brothers in Platt

2429 Street, some glass globes with a neck and flange at the bottom end, and with stoppers in them level with the flange ground and fitted. These glass stoppers we ground, or had ground more nicely by a glass cutter in Chambers Street, and I took them to a diamond cutter in Ann Street and had them perforated for the conductors. I think that this was the next thing after the Florence flasks and tube—I have mentioned calling the globes which I had blown over in Brooklyn in the shape of Florence flasks substantially, Florence flasks.

2430 1148 x-Q. You speak of globes you had blown over in Brooklyn. To what are you referring—globes used in Exhibit No. 1?

A. Yes; I have spoken of them before in this examination.

1149 x-Q. I was not aware that you had had special globes blown for the apparatus in Exhibit No. 1. Were these globes ordered before you went to Centre Street?

A. No; I think not.

2431 1150 x-Q. Were they ordered before or after the metallic bases of Exhibit No. 1 were ordered?

A. After.

1151 x-Q. After they were delivered?

A. Yes; after they had been delivered and the lamps run.

1152 x-Q. These globes must have been made with reference to the size of the base, must they not?

A. Yes.

1153 x-Q. Did you take the base over to the glass-

2432 blower?

A. Yes; the ring of one of the bases.

1154 x-Q. Who was the glass blower from whom you ordered these globes?

A. I can't remember his name. The factory was in First Street, or the continuation of First Street, east of South Fourth Street; I may not get the names of the

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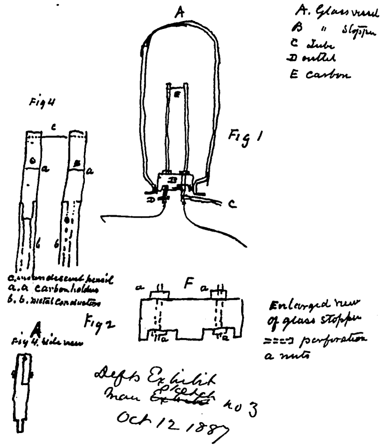

2433

streets right, but that indicates the location; three or four block to the right as you cross from New York by South Seventh Street Ferry.

1155 x-Q. Can you ascertain the exact situation of such factory, and if you can will you do so?

A. I cannot do so without going there specially. The factory is there; anybody can find it. It is or was a large glass factory.

1156 x-Q. In your 1147th answer you have described the third form of apparatus used. Please illustrate the 2434
ame same by a sketch

(Witness makes a sketch.) Same offered in evidence, and marked Defendant's Exhibit Man Sketch No. 3, October 12, 1887.

1157 x-Q. Did you order from Haggarty Bros. more than one globe and stopper as shown in this Exhibit No. 3?

A. I bought them ready made.

1158 x-Q. Do I understand that they were articles 2435
in stock?

A. I found them there and bought them.

1159 x-Q. Do you know whether they were articles in stock or had been ordered for some special purpose?

A. I assume that they were articles in stock or articles like some that had been ordered from them. They were articles such as are used in the windows of shops to exhibit oils, seeds and chemicals.

1160 x-Q. Were they then like bottles that could 2436
stand on their ends and had a glass stopper fitted into a flange and which could be inserted and removed?

A. Yes; except that I don't know that they had glass stoppers fitted to them; I think they had not when I bought them.

1161 x-Q. How many did you buy?

A. Three or four.

1162 x-Q. In your 1148th answer you say you ground or had ground the glass stoppers more nicely

2437 by a glass cutter in Chambers street. What is your recollection, that they were ground by you in Centre street, or had them ground by the glass cutter in Chambers street?

A. We had them ground by the glass cutter I have mentioned.

1163 x-Q. So as to make a better fit?

A. Yes.

1164 x-Q. Who was the glass cutter?

A. I don't know his name. His place was on the
2438 right side of Chambers street going east, a little way from Chatham street—a block or two.

1165 x-Q. Did you take them to the glass cutter?

A. Yes.

1166 x-Q. How did you find him, by looking up at the signs, or were you sent to him?

A. No; somebody told me of him.

1167 x-Q. Do you remember who told you about him?

A. No.

2439
1168 x-Q. Who was the diamond cutter in Ann street.

A. I don't know his name.

1169 x-Q. Whereabouts in Ann street was his place?

A. On the right hand side going from Nassau to William, up four or five flights of stairs.

1170 x-Q. How did you find this diamond cutter? By looking at signs, or were you sent to him?

A. I found him by requiring among the jewelers.

1171 x-Q. Did you buy these bottles and stoppers,
2440 take them to the glass cutter and have them cut by the diamond cutter the same day?

A. No, I think not. I bought them and took them to the glass cutter, I think, in the afternoon of one day, and the next morning took the stoppers to the diamond cutter and got the stoppers from the diamond cutter the same day I took them there. The diamond

cutter had done work for me before. I did not find 2441
him out for this work.

1172 x-Q. You say this diamond cutter had worked for you before. Now can't you tell me his name?

A. No; he was perhaps more properly a lapidary than a diamond cutter.

1173 x-Q. I presume you must have had the holes cut through the base with reference to the sizes of the tubes or conductors passing through the base?

A. No; I think we adapted the conductors to the 2442
holes, the holes being all of one size and about three thirty-seconds of an inch, as I recollect it. The leading-in conductors were hollow.

1174 x-Q. What supports for the carbons did you use in this apparatus? and who made the tubes and stop-cocks?

A. I don't remember any stop-cocks in connection with it. The conductors were tubular, flattened together at the upper end and brazed, with an orifice below the flattened portion. We may have had stop-cocks 2443
on them, but I think not. I think we pressed them together and soldered them up. The carbons were held at first, as in the first lamp I mentioned, by the spring of the conductors. We bought pieces of tubing, threaded them, put nuts on them, and did the work in the shop. We afterwards modified the manner of holding the carbons, both in these lamps and in the ones I first described.

1175 x-Q. Do you understand that all the metallic work of this apparatus was made in 43 Centre street? 2444

A. Yes, I think so; there was not much of it.

1176 x-Q. Who did the mechanical work?

A. I think old Mr. Sawyer did it.

1177 x-Q. Where did you get the tubing?

A. At Frasso's I think. He has two places. I cannot tell which it was; we bought things at both. One was in Fulton street, the other was in Chatham.

1178 x-Q. What kind of tubing was it?

2445 A. Brass tubing in stock, all sizes.

1179 x-Q. Now, in apparatus No. 3, none of the parts of the previous apparatus, as I understand, were used?

A. None, unless the carbons.

1180 x-Q. What was the object or design of this third form of apparatus?

A. To obtain a better sealed chamber of glass than with the brass caps, and avoid insulating either of the leading-in conductors otherwise than by the glass
2446 through which they passed. The form of the stopper and neck, in which it was placed, enabled us to cover the whole with sealing wax, which we did. Another object was to avoid separation of the parts by unequal contraction or expansion by heat, by making them all of glass.

1181 x-Q. What was the next form of apparatus used in your experiments at 43 Centre street?

A. A slight modification of this by closing up one of the tubes of the leading-in conductors at the lower
2447 end, leaving only one opening into the lamp. This was to enable us to charge the lamp by first exhausting and then allowing the gas to flow into the exhausting lamp, the open tube being branched outside of the lamp and fitted with stop-cocks for that purpose.

1182 x-Q. How many separate and entire apparatus of the kind shown in Exhibit No. 3 were made?

A. I think, of that extra kind, only three or four.

1183 x-Q. What was the next apparatus in which a conductor was run to incandescence at No. 43 Centre
2448 street?

A. Another modification of this last, which consisted in using iron wire for conductors, with a shoulder coming down upon the glass stopper inside the lamp, accurately fitted to the hole in the stopper, and with nuts at the lower side of the stopper, and one of the conductors was drilled out at the lower end to make it a tube opening to the air, and a hole

drilled into this tube on the side of the conductor in the lamp. 2449

1184 x-Q. Did you use for this modification globes and stoppers bought at Haggerty's?

Some of them, and some of them we broke and bought others.

1185 x-Q. Were the others of the same kind, and procured at the same place?

A. No; I think I bought all Haggerty had the first time, and I got others, but I don't remember where. 2450

1186 x-Q. Did you have the stoppers for these new bottles re-ground and holes drilled in them?

A. No; I think they were of smaller size in the neck and we had the same stoppers, so far as they were not broken, re-ground into the new bottles.

1187 x-Q. Who did this re-grinding?

A. This same man in Chambers street. I also got new stoppers for some that were broken and had them perforated by the same lapidary.

1188 x-Q. Who did the work in the metallic work on this modification? 2451

A. I think old Mr. Sawyer. I have no definite recollection. It might have been he or Mr. Sharp.

1189 x-Q. What was the next form of apparatus?

A. Still another modification of this, in having the glass stoppers shouldered so that the shoulder would rest on the end of the neck of the bottle, so that atmospheric pressure when the atmosphere was exhausted from the bottle or globe would not force in the stopper and split the neck of the bottle.

1190 x-Q. These stoppers with shoulders must have, as I infer, been specially made. Who made them? 2452

A. The same glass grinder or cutter in Chambers street.

1191 x-Q. You must also, I take it, have bought new stoppers?

A. We only made one of them, as I recollect; it

2453 may have been two, at most three.

1192 x-Q. These stoppers must also have had holes cut in them for the leading-in tubes; who cut them?

A. The same lapidary who peforated this stopper.

1193 x-Q. What was the next modification?

A. To use a plate of glass perforated for the conductors and ground and fitted to the flange of the globe, or bottle as you call it, instead of the stopper.

1194 x-Q. Was the plate of glass especially made and ground?

2454 A. No, not at first; we used pieces of plate glass for the purpose, and ground them with the flange until they were fitted tight.

1195 x-Q. Who made the perforations in the plate glass for the conductors?

A. We made them ourselves.

1196 x-Q. In what way?

A. In a lathe revolving a drill made of a copper tube, andusing emery.

1197 x-Q. Who did this work?

2455 A. Some Mr. Sharp did, and some old Mr. Sawyer did; some of it I did myself.

Adjourned until Thursday, the 13th inst., at 1 P. M.

THURSDAY, 13th October, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examin-
2456 ation of Mr. Man was continued as follows:

1198 x-Q. Was this work done in your shop at 43 Centre street?

A. Yes.

1199 x-Q. How many of such pieces of plate glass were so ground and perforated?

A. I think all our bases which we used on our lamps

at 43 Centre street were made of plate glass, but I may be mistaken in this, and it may be that some of them were blown in moulds while we were there. My recollection in regard to the matter is not distinct and, therefore, I cannot state the number; we had several dozens of them peforated by Mr. Sharp at his shop in Brooklyn; they were of different sizes. 2457

1200 x-Q. You have not understood my question; in Exhibit No. 3; as one of its modifications, you have said the glass globe or bottle was placed upon a piece of plate glass; holes or perforations being made in the 2458
plate glass; what I wish to know is, how many pieces of plate glass were perforated for this specific modification of the apparatus referred to?

A. I think only three, or at most four.

1201 x-Q Have you déscribed all the modifications made up to this time, in the apparatus referred to in Exhibit 1, 2, and 3?

A. No, I have latterly followed out the modifications in the glass simultaneously, and other modifications 2459
were made in the holders of the incandescent burners.

1202 x-Q. Well, what were those modifications?

A. The metal tops of the holders were cut off and pieces of carbon rod, in some cases square, and in some round, were substituted for the metal tops of the holders; at first these were fastened to the leading-in conductors by being wired to them, afterwards by drilling the metal tops of the holders and inserting the rods of the carbon into the hole thus drilled in the metal, so that the carbon tops of the holders extended above the 2460
metal of the leads or leading-in conductors. At first the carbons of the incandescent conductor were inserted at their ends in pits drilled in the carbon holder that is, the opposing faces of the carbon holders had depressions in them in which the ends of the incandescent conductor which extended between them were inserted, thus supporting the incandescent conductors,

2461

Afterwards a groove was made across the top of the carbon holders sufficiently deep to receive the incandescent conductor, which was laid in this groove across the tops of the two holders and packed in with powdered carbon; with this form of holders carbons of an arch shape were used, rising above the tops of the holders; a modification of the tops of the holders was also made, omitting the grooves just mentioned and making grooves in the tops of the holders at right
2462 angles to those last mentioned, to receive the ends of flat arch-shaped conductors.

Another modification was made in the tops of the conductors by omitting the grooves and filing notches out of the inside tops of the opposing conductors to receive flat arch-shaped conductors.

Another modification was to split the tops of the carbon conductors to a depth of about three-quarters of an inch, more or less, cut off one side of the top of each conductor, drill through the remaining portion of
2463 the top and the piece cut off, insert in the drill hole a small bolt with a nut, so that the piece cut off could be used with a bolt and nut as a clamp for holding the ends of the conductors. Where straight round pencils of carbon were used for the incandescent conductor, the parts were clamped together and holes drilled in the slit close to the tops of the conductor a little less in diameter than the carbon pencils, so that they could be clamped in the conductors by tightening the screw bolts, thus, as shown by Fig. 4 and Fig. 4 (*A*) of Ex-
2464 hibit 3, which figures I have just drawn on said exhibit.

Another modification, where other than ordinary illuminating gas was used as an atmosphere, was to first run the incandescent conductors after being placed in the holders, and after the whole interior works of the lamp were set upon the plate glass base—was to run these conductors up to the high incandescence in an atmosphere of hydro-carbon, usually illuminating gas,

first to heat the conductors, and second, by deposit of 2465
carbon, to perfect their electrical connection with the holders, then to take off the globe of the lamp, leaving the works all attached to the glass base, and cleanse and purify all the parts, including the globe, set them up in the globe again and charge the lamps with the atmosphere or vacuum we wished to use.

Still another modification was the introduction of spirally wound leading-in conductors, the convolutions of one conductor laying between the convolutions of 2466
the other conductor, making a double spiral tube, with short, straight ends to the conductors, which passed through the glass bases of the lamp, and short, straight ends at the tops electrically connected with the carbon holders of the incandescent conductors, the tops of the spiral conductors being held in place by a clamp electrically insulated from them. Following this clamp was the diaphragm of soap-stone or other insulating material shown in our first lamp patent, at first used for the same purpose of supporting and clamping the 2467
spirally-formed leading-in conductors. At the same time that we were using and setting up the Florence flask and seed vessels, or sample holders for globes, I procured from Mr. Hahn, a glass blower in North William street, near Chatham, several straight glass tubes closed at one end and open and with flanges at the other end. These we used simultaneously as globes for our lamps with the Florence flasks and with the seed bottles or sample holders, using with them plate glass bottoms perforated as I have described. Simul- 2468
taneously with the introduction of the plate glass bottoms, were introduced metal clamps to fasten the globes and plate glass bottoms together. Several modifications of these clamps were used, finally resulting in metal rings, one above the flange of the globe and one below the plate glass bottom, through which screws were passed outside of the flanges and plate glass, to fasten them together. In cases where the

2469 tops of the globes were larger than the diameter of their flanges, the upper ring above the flange was made in two parts overlapping one another and halved together, so that they could be put upon the flanges and make one continuous ring, when applied and screwed down to the lower ring. Now, I have spoken only of the apparatus of the lamp.

1203 x-Q. Were all those modifications which you have rehearsed at such length performed with the Florence flasks, purchased on the day you went to
2470 Centre street, and the three or four seed bottles purchased at the time you have mentioned?

A. All the apparatus which I have mentioned was made and modified, as I have stated, while we had in use Florence flasks and seed bottles, so-called, as globes for our lamps, and while we had in use at the same time we had in use for globes for our lamps the tubular globes which I had bought from Mr. Hahn, as I have stated, and while we had in use globes which I procured to be blown at two glass factories in Williams-
2471 burg, Brooklyn. We had all four kinds of globes, which I have mentioned, and also Florence flask globes, or globes of the general shape of Florence flasks which I had blown at the glass factory I have mentioned in Brooklyn, all at the same time.

1204 x-Q. When we adjourned yesterday, as I understood, the only globes you had referred to were the Florence flasks, bought by you on the day you went to Centre street, the piece of tubing you brought over from your house, which was used in the second exhibit,
2472 the three or four seed bottles that you bought at Haggerty's, and the others referred to in your 1188th answer, and a few globes like Florence flasks, which you had made at the glass house in Williamsburgh the only stoppers, were those ground by the glass grinder or cutter, whose name and place of business you have forgotten, and which were perforated by the diamond cutter of lapidary to whom you referred. You also

mentioned that you yourselves cut holes in a piece of 2473
plate glass as a base. The only metal parts you had got were those bases and parts you had ordered before you went to Centre street, and the caps and holders for the apparatus of the second exhibit which were made for you. Now, in the numerous experiments to which you have referred in your answer to the 1202nd cross-question, were none other than these globes and bases or caps used?

A. I have already stated that glass bases were used. 2474
No other metal bases like those we ordered before we went to Centre street were used, at least not to my present recollection: but other globes than those that I mentioned yesterday, and other than any I have mentioned to-day, were used by us while the modifications and changes I have mentioned were being made, and while still the Florence flask lamps and the seed vessel globes were being made by us.

1205 x-Q. What I would like to know is, whether any metal base other than those made by you before 2475
you went to Centre street, or made after you went there for the apparatus of the second exhibit, were used in the series of experiments mentioned in your answer to the 1202nd question?

A. I do not recollect any others until outside metal covers, spun caps, for the whole base of the lamp were used by us; and these were later on.

1206 x-Q. Did you use other glass stoppers or bases than these few you have described? I understood 2476
you only to have referred up to the present to the stoppers ground by the glass cutter in Chambers street, and perforated by the lapidary in Ann street, on the one occasion you went to these places, some pieces of glass perforated by Mr. Sharp, and the pieces of plate glass which you yourselves perforated and ground, by rubbing the flask or bottle upon the glass, it first being powdered with emery?

A. I will state the fact, and if I have not stated it

2477 before, or have not made myself clear, this will be a correction. At first we got a few pieces of plate glass, some of them cut in circles, and some square. We perforated, or got perforated for the conductors, one of these. We ground the face of the flange on one of the seed bottles, on a lap or face plate, with emery, to make it level and true, until we got it substantially polished. The plate glass was already true and polished. We then ground the flange and plate glass together until
2478 their junction was air-tight. We then set up a lamp upon it—the internal parts of a lamp. After this we got more pieces of plate glass at different times. We perforated and ground some of them ourselves, and Mr. Sharp perforated and ground a large number of them at different times for us. They were only comparatively a few of them used upon the seed vessel lamps, so called; a much larger number being used upon globes of other forms, such as the tubes I got from Mr. Hahn, like big test tubes, and other globes of which I have not
2479 yet given an enumeration.

Adjourned till Friday, the 14th inst., at 10 A. M.

Friday, Oct. 14th, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man proceeded as follows:

2480 1207 x-Q. What are the globes to which you last referred and where were they bought?

A. I got them blown at two glass factories I have mentioned in the Eastern District of Brooklyn, Williamsburgh. They were like the tubes I bought of Hahn with a flange at the bottom, open at the bottom, parallel sides rising from the flange and a bulb blown at the upper end which was closed. They were similar in shape to a broken globe, an exhibit in this case

heretofore introduced and marked "Exhibit No. 29, globe of lamp produced by Albon Man, April 15th, 1887." 2481

1208 x-Q. How many about of these were bought?

A. I can't tell; I have no distinct recollection in regard to numbers. It was a large number, I think more than a hundred; I can't be certain. At first, a few only, and afterwards more and more.

1209 x-Q. These were specially ordered, as I understand? 2482

A. Yes, and they were of varying proportions and sizes and shapes, but the exhibit broken globe is a type of them.

1210 x-Q. Am I correct in understanding, that in all the apparatus to which we have been referring the incandescent conductor extended across, from or near the tops of two parallell supports or leads, running perpendicular to the base of the lamp, as shown in substance in Exhibit No. 3?

A. Yes, as shown in substance in Exhibit No. 3, but 2483
in this exhibit the incandescent conductor is shown as extending straight across from one holder to the other; in some of our lamps of this type this conductor was of an arched or circular form rising above the tops of the holders.

1211 x-Q. Now as I understand, before you went to Centre street you ordered in the neighborhood of ten metal bases which had been delivered on the 6th or 7th of March, and that you, on the same day or evening of the day previous, bought between half a dozen 2484
and a dozen Florence flasks to use as globes with these caps and that you also had had made the supports or holders for the conductor, so that on the first day or two after going to Centre street you had these parts ready to assemble?

A. Yes, we bought the globes on the evening previous and we had the parts all ready to assemble when we went there.

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1212 x-Q. Did you have any carbon conductors ready to put in these parts?

A. Yes.

1213 x-Q. Conductors made previously to going to Centre street, or after you were there?

A. I think the conductors were bought by Mr. Sawyer before we went to Centre street, but it may have been on the morning of the day we went there.

1214 x-Q. Did you put these parts together on the
2486 first day and run the conductors to incandescence?

A. Yes, Mr. Sawyer and his father did, and I was present when the current was turned on to the lamps.

1215 x-Q. Was more than one so-called lamp made that day and run to incandescence?

A. Yes, six or eight of them; as many as Mr. Sawyer and his father could get ready were lighted up.

1216 x-Q. What atmosphere was used on this day?

A. Simply illuminating gas.

1217 x-Q. What was the kind of carbon used on this
2487 first day?

A. Small pencils cut from rods of French carbon about the diameter of the smallest knitting needles, perhaps less than that; rods of that diameter.

1218 x-Q. And these, as I understand, had been cut to the desired size so as to be adapted to the other parts of the lamp which had been previously ordered, and that all that you had to do on this day was to put the parts together.

A. The carbons were already of the desired diame-
2488 ter and only required to be cut off to the length we wished to use; and the ends were cut, smoothed off. I think this cutting off was done by Mr. Sawyer as the lamps were set up.

1219 x-Q. Will you please describe the construction and material for the supports for the carbons. I mean the leads in this apparatus?

A. They were made of copper rods, screw-threaded

2489

at the lower end; were attached to the base and hammered out flat at the upper ends and filed off to be of the same width, after hammering flat, as the diameter of the copper rods. One was simply screwed into the inside of the base, the other passed through an insulation in the base, had a hole through it in which to insert the electrical connecting wire outside the base with, I think, a binding screw to hold the wire. They were between a quarter of an inch and half an inch in diameter, and the flattened part at the upper ends was about 2490
an eighth of an inch or less in thickness; I have mentioned the facing of these leading-in conductors with platinum at the points where they held the ends of the incandescent conductors; I think this platinum facing was not on the first holders that we used, but was put on almost immediately after first using them; these leading-in conductors or holders were about six inches in length inside the globe.

1220 x-Q. How long did you use these apparatus before any change whatever was made in the construction of the caps, carbons or holders? 2491

A. I cannot recollect how long; I think the first change we introduced in that kind of apparatus was the facing of the holders with platinum; this was done almost immediately; in a day or two.

1221 x-Q. With the exception of the facing the supports with platinum, did you try these apparatus without change of any kind for two or three days?

A. Yes, I think so, and longer, but am not certain.

1222 x-Q. In running these conductors to incandescence did you use the arc light machine in the base- 2492
ment?

A. Yes.

1223 x-Q. What trials, tests or experiments did you make to ascertain the efficiency of these apparatus and their parts, and what did you conclude from these tests?

2493 A. We lighted them up and at first the carbons soon fell out of the holders. We discovered that the copper holder was fused where it touched the incandescent conductor. We therefore faced them with platinum, which only melts at a very high heat. After we had done so we discovered that a deposit of carbon was being made upon the incandescent conductors from the hydro-carbon gas, at first hard and dense, and as the deposit went on and the incandescent conduct-
2494 ors increased in size their resistance was decreased and the deposit became sooty and loose, and grew rapidly to such a size that the carbons were no longer luminous. We coupled them up in series and in single multiple arc and in multiple arc series, to see which was the best method of coupling with the current we were using. I do not now recollect anything else. Yes, I do recollect something else. The dynamo was run from an engine driving all the machinery in a very large building. It was driven faster or slower, as more
2495 or less work was done in different parts of the building, and we discovered that its electro-motive force was very variable, and that some regulation was needed. We discovered that the electrical connection betwee the holders and the incandescent carbons was not suitable, and that with the variable electro-motive force of the dynamo machine an electric arc was liable to form at the points of junction between the incandescent conductors and the holders, by which the holders were fused and the carbons dropped out.

2496 1224 x-Q. Was this last before you had the holders faced with platinum?

A. Both before and after.

1225 x-Q. Do I understand then that the first defect in the construction of the apparatus you ascertained was the heating of the copper holders at the point where the carbon was inserted in them?

A. Yes, that was the first, I think.

2497 1226 x-Q. And to obviate that you had the holders faced with platinum?

A. Yes.

1227 x-Q. Now, about how long from the time you first run the lamp did you notice this defect and determine to try the facing of the holders with platinum?

A. I think it was the first day we run them. It was almost immediately, I think, after we commenced lighting the lamps.

1228 x-Q. As I understand you, then you went out 2498
and got some platinum and had the holders faced. Did you use the same holders as had held the conductor when incandescent, or did you get new ones made?

A. Used the same holders.

1229 x-Q. Who was it that faced the holders with platinum?

A. I have already told you that I don't know.

1230 x-Q. In what form did you buy the platinum?

A. I do not remember; either in wire or a straight 2499
flat strip, I think.

1231 x-Q. About how long was it before you received the holders, tipped with the platinum, and put them in the apparatus?

A. I cannot tell. My best judgment in regard to the thing is, that perhaps only one pair of holders was first tipped with platinum, and afterwards the others. Looking back upon the matter now, I should think that we had one or more pairs of holders tipped and put to use the next day after we got there, but it would not 2500
surprise me if told by some one who absolutely knew, that it was several days or a week; I do not think it was as long.

1232 x-Q. It was Sawyer that got the holders tipped with platinum, was it not, or was it yourself?

A. I think it was Sawyer.

1233 x-Q. As I understand, you found that the platinum also heated and fused?

2501 A. Yes.

1234 x-Q. What did you then do to correct this defect?

A. We introduced a side circuit, or circuits with a switch, to turn more or less resistance into the side circuit, so as to turn more or less of the current into the lamps, and in some measure compensate for, or regulate the variable current coming from the dynamo, so that we would not get in the lamps at any time a
2502 current sufficient to fuse the platinum of the holders, or establish electric arcs between the holders and the carbon.

1235 x-Q. Did this have the desired effect?

A. Only partially, as it was not automatic.

1236 x-Q. This endeavor was not in improvement of the apparatus, but in the regulation of current; what did you next do in the way of alteration of parts, or modification of parts, to overcome the arc of heating at points of contact between the carbon and the hold-
2503 ders?

A. I cannot at this length of time pretend to give with accuracy in their regular order of series, the different things that we did, and I wish to be understood in all my answers in that way. I give the next thing that now occurs to my mind. We cut off the metal tops of the holders, and substituted for the metal, carbon tops.

1237 x-Q. Were the lamps required to be run any time, to ascertain this heating of the holder at the
2504 points of contact with the carbon?

A. I think we discovered it almost at first.

1238 x-Q. Was a day, or two or three days, required to convince you?

A. I think it was the first day.

1239 x-Q. As near as you now remember, how many days was it after going to Centre street that you tried putting carbon tops on the supports?

A. I can't tell.

1240 x-Q. Can't you tell me about? 2505

A. I can only guess at it; I guess, a week or more.

1241 x-Q. During the time that you were trying this first apparatus, and endeavoring to overcome the heating of the points of contact of the carbon at the holders, by trying platinum, and before trying the carbon tops, were you experimenting with other parts of the apparatus, the globes, bases atmosphere or carbon?

A. Yes, I think we were.

1242 x-Q. Please tell me what parts you were exper- 2506
imenting with, what defects you had noticed, and how you endeavored to overcome them. I am referring to a period anterior to the time of the carbon tops?

A. We discovered in a day or two that the sealing of the lamps was defective. Leaving them standing over night charged with illuminating gas or hydrogen gas, I forget which, the current was turned on the next day upon one of the lamps, or more, and they exploded, showing plainly that they had taken in atmospheric air, which mixed with the atmosphere with which the 2507
lamp was charged, formed an explosive mixture, showing that the lamps leaked. This necessitated our frequently and continually renewing the atmosphere of the lamp, re-charging it. The Florence flasks were too thin at their necks to be ground for stoppers; we therefore got the seed vessels of which I have spoken, which were thick enough to be ground for glass stoppers, as I have already described; we endeavored to remedy the production of the arc by inserting the ends of the carbon more deeply in the holders, and we en- 2508
deavored to form a deposit of carbon at the ends of the incandescent conductors, to make better electrical connection between them and the holders. We packed around the ends of the incandescent conductors in the holders powdered carbon in a paste to make better connection; we enlarged the ends of the incandescent conductors by using larger carbon rods to make them, and working them down small between the enlarged

2509 ends; it is impossible for me to distinguish the globes or vessels in which these things were first done. I know we did them in the Florence flask which we first had and afterwards bought, or in some of the Florence flask-shaped globes which I had blown in the glass factory in Brooklyn, a sample of which I now produce; it is altogether probable, too, that some of these things were done, and I think they were, in the seed vessel globes I have mentioned. In this period anterior to the carbon tops we were endeavoring to get a better
2510 sealed lamp in the manner I have described; we were also endeavoring at the same time to get a better atmosphere for our lamps; we first used hydrogen for this purpose and next nitrogen; we also pumped the lamps out before sealing them when filled with hydro-carbon or illuminating gas, to prevent the rapid deposit upon the incandescent carbons.

Adjourned until Monday, the 17th int., at 1 P. M.

2511

MONDAY, Oct. 17th, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows:

1243 x-Q. Is it at your present recollection that while using the metal caps and apparatus of Exhibit No. 1, and before the glass stoppers were tried, instead of the caps, you deposited carbon around the ends of
2512 the incandescent conductor, or packed powdered carbon in a paste around the ends, or enlarged the ends of the carbon, as described in your last answer?

A. I think so, but at this length of time I cannot be positive in regard it, except as to the deposit and enlarged ends; I feel confident that those things where done in the Florence flask lamps with the metal bases.

1244 x-Q. Is it also your recollection that while

using the flasks and metal basses of Exhibit No. 1, and before the use of the glass stoppers, you had tried in the lamps of the flasks and metal bases, atmospheres of nitrogen and hydrogen and had also exhausted them, with an air pump? 2513

A. It is, according to the best of my recollection in regard to the matter, and I cannot pretend to be positive in regard to it at such a length of time, that before getting globes with glass stoppers we had exhausted the lamps, or partially so, by an air pump and had 2514
used the atmosphere of hydrogen. I cannot remember the order of events well enough to say whether or not we used nitrogen up to the time we got the lamps with glass stoppers.

1245 x-Q. Then while still using the Florence flasks and metal bases of Exhibit 1, and before trying the glass stoppers, it is your present recollection that you had an air pump, or the use of one, and had obtained or made hydrogen?

A. Yes. 2515

1246 x-Q. With these flasks and metal bases and before glass stoppers were used or tried, did you try different kinds of carbon?

A. I don't recollect any; we may have done so; I think only one kind of cardon; I recollect we used more than one kind with the first apparatus; we got some lead pencil leads and baked them, and used, or tried to use, some of them.

1247 x-Q. Was the object of trying the glass stoppers, instead of the metallic bases, to obtain an appara- 2416
tus which would better preserve the atmosphere of the lamp.

A. Yes; it could be better sealed up and better insulation of the wires from each other was obtained for the leading-in conductors.

1248 x-Q. When these glass stoppers were tried I also understand the supports or leads, as you call

2517

them, were made hollow and were used for exhausting
or charging the globes?

A. Yes, with various modifications; this was first
done in globes of that kind.

1249 x-Q. With the use, then, of the glass stoppers,
I understand, three objects were had had in view: one
an apparatus better adapted for the preservation of
the atmosphere within the chamber; two, the insula-
tion from each other by the structure of the apparatus
itself of the leads or supports; three, the use of these
2518 leads or supports in charging or filling the globe by
having them hollow?

A. Yes, those are the salient points.

1250 x-Q. So far as the carbon itself was concerned,
or the means of attaching the carbon to the supports,
these points were independent of the other features of
the apparatus of either Exhibit 1 or 3?

A. Yes, we might improve the interior works of the
lamp and the incandescent conductor, using either.

1251 x-Q. Do you remember whether you had suc-
2519 ceeded in so attaching the incandescent conductor to
the leads as that an arc would be prevented in the
flask and metal base lamps, and before trying the glass
stoppers.

A. You refer to the arcs at the ends of the incandes-
cent conductors. Both kinds of these lamps were
being run while this matter still troubled us. We did
not consider it altogether due to the lamps, but to the
want of regularity in the currents, and we had not got,
up to the time of getting the glass stoppers, a regular
2520 current or a means of regulation sufficient to prevent
this trouble; nor had we remedied it completely in
any other way.

1252 x-Q. In the lamp of Exhibit No. 1 of the flasks
and metal bases, had you found difficulty in insulating
or preserving the insulation between the supports and
the metal base?

A. Only mechanical, and the difficulty of sealing up

2521

due to the construction. It was a complexity of struc-
ture which we desired to avoid.

1253 x-Q. Now, in this apparatus of Exhibit No. 1
of the flasks and metal bases, you discovered, as
I understand, two defects—one, the arcing at the
point of contact of the carbons and the holders; and,
two, the difficulty to preserve the atmosphere. Was
this apparatus sufficiently good as a lamp to enable
you to make any tests of the relative efficiency of differ-
ent gases as an atmosphere or the use of a vacuum?

A. Yes. 2522

1254 x-Q. Did you make such tests?

A. Yes.

1255 x-Q. What were the tests?

A. We first used hydro-carbon gas—ordinary illum-
inating gas from the gas main. With such gas, I have
explained that the deposit of carbon soon prevented
the incandescence of the incandescent carbon. By
pumping them out or exhausting them, we found that
the incandescence was much longer preserved, but that
with the vacuum we got, the atmosphere was still not 2523
appropriate. We next used hydrogen gas, because we
had not nitrogen, and found it better than hydro-
carbon gas. We next, in these lamps, used
nitrogen gas, and found it the best. We exhausted
our lamps with all three kinds of the gas. We found
that there was danger of explosion with the hydrogen
and hydro-carbon gas. Perhaps it would be better to
say that we knew this before, and found that there
was danger of leaking, by which the explosive mixture
would be formed. This, of course did not exist with 2524
the nitrogen gas.

1256 x-Q. Did you ascertain these results by taking
different apparatus of the character of Exhibit No. 1
and running them under the same conditions—that is,
the same current, same carbons, same methods of
attachment between carbons and leads, same leads

2525

same forms of globes and bases, same methods of attachment between globes and bases, but different atmospheres or gases, including a vacuum?

A. With the hydro-carbon gas we set up all the lamps; charged them all with hydro-carbon gas; exhausted some; we run them all with the same current. The test for hydrogen gas was made by charging the same lamp with hydrogen instead of hydro-carbon and running them by the current and observing that
2526 no deposit was formed; the same with the nitrogen. I don't think we discovered any particular difference in these lamps charged with a hydrogen or nitrogen atmosphere, whether they were exhausted or not. We may have done so; but if so, I do not recollect it.

1257 x-Q. Why, then, did you not determine in this apparatus what the most efficient atmosphere was, you did ascertain that these metal bases were not adapted to the preservation of any atmosphere?

A. We discovered that the *construction* was not
2527 suitable to the permanent preservationof any atmosphere, and we proved that certain atmospheres were unsuitable, to wit, hydro-carbon.

1258 x-Q. What was the longest time you succeeded in running at continuous incandescence a conductor in the apparatus of Exhibit No. 1?

A. That I cannot recollect; I kept no memoranda of it. I can only say that people came in to see the lamps, stopped there and watched their running as long as they wanted to, and then the lamps were put
2528 out.

1269 x-Q. Do you know of one ever having run at continuous incandescence as long as ten minutes?

A. Yes, and very much longer.

1260 x-Q. As long as an hour?

A. Yes; I think longer than two or three hours.

1261 x-Q. Did you ever make, while at 43 Centre street, a lamp containing the different parts described and shown in Letters Patent 205,144?

2529

A. In detail exactly like that?

1262 x-Q. Yes?

A. I do not know; in detail similar to that, yes.

1263 x-Q. What parts in this lamp are you doubtful about being in the lamp substantially like the description in this patent?

A. I do not know that any part was omitted; if any, the part G; and I know t..at lamps were built by us there with the part G in them, in which the construction was not in all respects like this lamp. 2530

1264 x-Q. In what respects did it differ?

A. At this length of time, I cannot tell in what minute respects differences occurred in our lamps. In one lamp that I recollect, in which the part G was included, the leading-in conductors, instead of being separate spirals, were concentric spirals. In another, I remember straight leading-in conductors were used; in another, I remember conductors of flat metal, folded upon themselves. In another, I remember a spring used as a
substitute for the weight of the part F. In a great 2531
many lamps I remember the omission entirely of G; some with springs substituted for the weight of F, and some in which the weight F was used. I remember a number in which neither springs nor weights were used as a suiostitute for weight F, in which the leading-in conductor with which F connects was made sufficiently flexible to allow the insertion of the incandescent carbon. So that it was held, you may say, by the spring of the whole leading-in conductor.

1265 x-Q. In the lamp of this patent, several differ- 2532
ences and additions appear to have been made from the apparatus or lamps of Exhibits 1 and 3. The conductor is straight and perpendicular to the base of the lamp instead of being supported between two parallel leads. The leads are made spiral so as to give greater length. A soapstone disk to prevent downward radiation of the heat is introduced in the centre of the lamp, and the base consists of several parts fitted

2533 elaborately together. Why were these modifications made?

A. They grew up through a long series of modifications from Exhibit 1, as you call it, for different purposes, and I doubt whether I can now recollect or recall all these changes, or the reasons for them moving us to make them. In fact, I know I cannot remember all. If you desire, I will go on to state some of them; I have already mentioned how the diaphragm arose. I have also mentioned the substitution of carbon for metal
2534 in the connections with the incandescent conductor. I have also mentioned the clamping of the carbons of incandescent conductors in straight carbon holders, some staight and some arched, so as to rise above the ends of the holders. The arrangement in this lamp is evidently intended to allow for expansion and contraction of the incandescent conductor. The upright position of the incandescent conductor is evidently more favorable to the radiation of light from it in a horizontal direction than a horizontal position of a
2535 straight incandescent conductor, with its holders preventing radiation of light at the ends of such conductors in two directions, casting upright shadows. The diaphragm introduced first for support was supposed to prevent radiation of heat also from the base of the lamp where it was sealed up and where, by expansion and contraction, leaks were most likely to occur. The extended lengths obtained by convolution of the leads was intended to prevent conduction of heat to the glass base where it was sealed in the same. The construc-
2536 tion of the base was intended to obtain perfect hermetical sealing of the lamp, so as to preserve its atmosphere uncontaminated.

1266 x-Q. This patent was applied for on the 16th of May, 1878. At this date you and Mr. Sawyer had about completed your experimental work at 43 Centre street, had you not?

A. I do not remember whether we had or not. We

did some work there, how much I don't know, according to the best of my recollection, after the application 2537
for that patent; the great majority of the work we did was done before this time.

1267 x-Q. When you filed this application I understand you to have considered the lamp described in this patent, an incandescent lamp adapted for use?

A. We considered that the lamp there described contained the elements of a practical electric lamp.

1268 x-Q. The lamp of this patent shows a straight 2538
carbon fed down upon the block D to compensate for fracture or slight consumption of the carbon. Have you found in your experiments with the apparatus of Exhibit 3, where the carbon was supported between parallel leads, that fracture or consumption of the carbon occurred?

A. In a great many cases the carbons were fractured, and in others some consumption at the ends occurred. In a great many other cases neither fracture nor consumption occurred in the incandescent carbons; the 2539
fracture and consumption were considered accidental by us, and it was to compensate, as far as possible, or provide against accident, that this provision in the lamp was made, and also to cover it, this feature, in a patent for a lamp.

1269 x-Q. When you say in your last answer that you consider the fracture and consumption accidental, what do you mean?

A. That it ought not to occur in a well constructed lamp, properly used and run, but that it was possible 2540
that it might occur through faulty construction or charging, or accidental use of currents of too great a strength, as happens to-day in incandescent electric lamps in both respects.

1270 x-Q. Were your lamps well constructed?

A. Yes.

1271 x-Q. Am I to understand then, that if the

2541 lamps were properly constructed, charged and run, as yours were, this fracture and consumption would not occur, but that if the lamps were improperly constructed, charged and run, it would occur?

A. I mean that it *might* occur with all the care that would be ordinarily bestowed in careful manufacture and charging of the lamps and in ordinarily careful use of the same, as it occurs to-day in the incandescent lamps now manufactured, and I mean in this to make a distinct admission that as much was not known
2542 then in regard to the manufacture of incandescent lamps as is to-day, nor of the life of a lamp which would render it commercially acceptable. We meant to provide against possible contingencies.

Adjourned till Tuesday, the 18th inst., at 10 A. M.

NEW YORK, Oct. 18th, 1887.

2543 Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man continued as follows:

1272 x-Q. I do not quite understand from your previous answers whether, prior to May 16th, in lamps where the carbon conductor was supported by parallel leads, you had or had not been able to prevent fracture or consumption of the carbon conductor at the point of contact between the conductor and the leads?

2544 A. In some cases we had, and in some cases there was fracture, and in some cases consumption.

1273 x-Q. You say that in some cases fracture and consumption did occur and in others not. Had you found any means by which sufficient good contact could be obtained to prevent fracture and consumption?

A. Yes; we did not attribute the fracture to the points of contact; nor did it frequently occur there;

2545

nor did we attribute the consumption to the points of contact, but to impurity of the atmosphere of the lamps ordinarily; or, in cases other than that, in using too great current, so as to cause arcs where they would not occur with a proper current. In other cases, fracture occurred by the putting of too great tension, or pressure upon small carbons.

1274 x-Q. I do not as yet understand you. When you began your experiments, one of the first difficulties you encountered was destruction of your carbons, by consumption or fracture, at the points of contact be- 2546
tween the carbons and the holders. In your first patent for a lamp, filed May 16th, in enumerating the reasons why, up to your time, no lamp had as yet been devised which would be practically operative, you say:

"Third. The unequal expansion of the carbon and "its holders had resulted in fractures of the former, so "that, however perfect the atmosphere in the globe, "the lamp has never been permanent."

To obviate this defect, you describe in the patent a 2547
rod of carbon resting upon a block of carbon D, so held and arranged that as fracture or consumption occurs at the point of contact between D and A^1, the carbon is fed downward. This arrangement does not appear to be to prevent fracture or consumption, but to prevent the disastrous effect of such fracture and consumption, the patent seeming to state that fracture and consumption, by unequal expansion of the carbon and holders, cannot be prevented. Now, was it true, at the time you filed the application for the patent, that you had been 2548
unable to devise a method of rigidly holding the carbon conductors and of so connecting them as to prevent fracture and consumption?

A. You cannot expect me to answer yes or no, and so adopt your answer as my testimony in cases like this. You confound two separate and entirely distinct things and apply the wording of the patent to a matter to which it does not refer and then ask me to adopt your

2549 question and answer yes or no. I referred in my previous testimony, to which you refer in your question, to the imperfect electrical connections between the holders and the incandescent carbons the consequent formation of electric arcs, the consumption of the ends of the carbons, and melting away of the metal points of contact. Now, you confound this matter with a breakage expressed to be due, not at all to the difficulty to which I referred, but to the unequal expan-
2550 sions of the incandescent conductors and the leading-in-conductors and to compensations for this latter difficulty, of which I have not before spoken at all. Again, you confound the kind of destruction or consumption at the ends of the incandescent conductors by the electric arc, of which I *have* spoken, with consumption, wearing away or oxidization of the substance of the conductor itself by reason of an imperfect atmosphere, of which I have not spoken. If you ask me the question without your premise, to which I am ex-
2551 pected to assent in my answer, I will answer it.

1275 x-Q. Whatever the cause of the fracture or consumption may have been—whether due to an arc resulting from imperfect contact, and thus consuming the carbon or metal, or a break or fracture due to unequal expansion or contraction of the carbon and holders—the result would be, would it not, the destruction of the lamp ?

A. Yes, if the fracture occurred or the consumption took place, and if, also, there was no automatic com-
2552 pensation provided in the lamp by which the fracture or consumption could be remedied.

1276 x-Q. Now, in order then to rigidly connect the incandescent conductor to its supports and make this connection practicable and durable, you would have to so connect them as to prevent fracture or consumption, whatever the cause might be, would you not ?

A. Yes, so far as fracture or consumption are influenced by or depend upon the connections.

2553

1277 x-Q. In patent 205,144 you state: "At the "present day it is not new to produce a light by caus-"ing the electric current to heat a carbon conductor to "incandescence in a vacuum, or in nitrogen, or in other "gas ; but no lamp has yet been devised which would "be practically operative and for these reasons." You then enumerated as your reasons the following :

"First. The methods that have been employed for "charging the lamp with the artificial atmosphere "* * * * are imperfect. 2554

"Second. It has been found practically impossible, "under the varying degrees of heat and pressure, to "maintain perfect joints, and the result is that expan-"sion of the artificial atmosphere by the heat from the "luminous conductor expels a portion of the same, and "the contraction of the atmosphere, upon cooling, "causes a portion of the external air to penetrate the "globe * * * * * ."

The third season you give why no lamps have as yet 2555
been devised which had been practically operative, is that "the unequal expansion of the carbon and its hold-"ers, has resulted in fractures of the former, so that "however perfect the atmosphere in the globe, the "lamp has never been permanent."

Later on you say : "Our arrangement for avoiding "fracture of the carbon will be fully described herein-"after."

The patent then describes a structure wherein the incandescent conductor is not final or rigidly attached to, but rests and is held by pressure upon a carbon 2556
block D, "with a mechanism by which, in the language "of the patent, should fracture or slight consumption of "the carbon occur at the first lighting, or any subse-"quent lighting of the lamp, the necessity of taking down "the same, renewing the carbon, and recharging the "globe, is obviated in as much as the weight of rod F "gently forces the carbon through the clamp G until "a new contact between E and D is established."

2557 As this patent states, that however perfect the atmosphere in the globe, one of the reasons why a practical operative lamp has never been devised, is that unequal expansion of the carbon and its holders has resulted in fractures of the former, and shows and describes no method by which a rigid or firm attachment between the incandescent carbon and its support can be made so as to avoid this fracture or consumption, but on the contrary describes an arrangement by which fracture or consumption is not prevented, but the
2558 destructive consequences are compensated for by new contact being made. I desire to know whether, at the time you filed this application, you had found a means of firmly and rigidly uniting the incandescent carbon conductor to its electrodes or supports, so that fracture or consumption would not occur?

A. Up to the present time, so far as I know, no positively permanent incandescent electric lamp has ever yet been made. Among the reasons for this are those given in this patent. In answering this question, then,
2559 I must be understood as speaking relatively and use the word "permanent" in a relative sense. Using it in such sense, and meaning it permanent, I answer the question, yes, in at least two forms, one of which was intended to be shown in Figure 8 of the patent, employing a straight pencil, and the other of which employed an arch form of incandescent conductors held between clamps and rising above the holders, in each of which the connections were rigid and packed with carbon or united to the holders by a deposit of carbon.
2560 It will be observed that in Figure 8, by description, the clamp G is omitted.

1278 x-Q. You do not mean in your last answer to say that Figure 8 of the patent shows a permanent attachment of the carbon E to the block D, or that the patent describes such a connection?

A. No, I do not know that it does. I referred in that figure merely to the form.

1279 x-Q. Do you mean by your 1277th answer to 2561 be understood as saying, that at the time of the filing of this application, May 12th, 1878, you had devised a means of attaching the carbon conductor to its supports or holders so that fracture or consumption of the carbon would not occur?

A. Yes, any fracture or consumption due to imperfect connection between the incandescent carbon and its holders, or due to unequal expansion and contraction between the carbon and its holders, to a practical ex- 2562
tent.

1280 x-Q. If that be so, was not such a construction much simpler than the one shown in Patent 205,144?

A. Yes, but it did not serve the same purpose as that described in the patent, and perhaps it was nothing new, except possibly the deposit carbon.

1281 x-Q. Do you mean by your last answer, at the time you filed the application, means were known by which a rigid and firm attachment could be made between the carbon and its holders or supports, so that 2563
fracture or consumption would not occur by reason of defects in the joint?

A. Yes; or at least they were so simple that we supposed they must have been used.

1282 x-Q. Was it then true, as stated in the patent, that one of the reasons why no practically operative lamp had been devised, was fracture due to unequal expansion or contraction of the carbon in its holders?

A. Yes.

1283 x-Q. Was this statement in the patent intended 2564
as a historical statement of fact, or a statement that no fixed joint could be made in which fracture could not occur?

A. It was a statement simply of our views as to the cause of previous failures and in explanation of what we desired to remedy.

1284 x-Q. What made you think that one of the reasons of previous failures was due to fracture at the

2565 joint, if, as you have said in your answer to the 1281st question, means were known by which a rigid and firm attachment could be made between the carbon and its supports, so that fracture or consumption could not occur by reason of defects in the joint, or were so simple that you supposed they must have been known?

A. I call your attention to the fact that the patent does not state that the fracture is due to unequal expansion of the carbon and its holders at the joint, but simply states that "the unequal expansion of the car-
2566 bon and its holders has resulted in fracture of the former," omitting "joints." Answering your question directly, I have already stated in my testimony that we found that electric arcs were formed at the joints by reason of imperfect electrical connection, resulting in the consumption or wearing away of the carbons at those joints. It was so obvious, I suppose, that we assumed that others had observed the same thing, if we did, but we do not state so in the patent, and I do not remember to have so testified.

2567 1285 x-Q. You do state in the patent, do you not, as one of the reasons why no lamp had yet been devised which would be practically operative, that unequal expansion of the carbon and its holders has resulted in fracture of the former; so that, however perfect the atmosphere in the globe, the lamp has never been permanent?

A. Yes; and we show a means of counteracting the injurious effects of this unequal expansion and contraction.

2568 1286 x-Q. In your 1283d answer you say this statement was a statement of your views as to the cause of previous failures and an explanation of what you desired to remedy. In your 1281st answer you say that at the time you filed the application you thought means were known, or they were so simple you thought they must have been known, by which a rigid and firm attachment could be made between the carbon and its

holders, so that fracture or consumption would not occur by reason of defects in the joint. If, then, it was so easy to connect the carbons and holders so that fracture would not occur, why did you think that previous failures had been due to imperfect union? 2569

A. I do not know that I have anywhere testified, and have not intended to do so, that previous failures had been due to the imperfect union, and the patent does not so state, but that it is due to unequal expansion between the carbon and its holders, to wit; the carbon 2570
expanded more or less than its holders and was broken thereby, and not by imperfect connection.

Adjourned till Monday, the 24th inst., at 1 P. M.

MONDAY, 24th October, 1887.

Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows: 2571

1287 x-Q. Do I understand from your last answer that you mean to say, not that a fracture occurs at the joint necessarily by reason of the unequal expansion and contraction of the carbon and its holder, but that from this cause a fracture is liable to occur in any part of the carbon unless prevented by some proper means?

A. That is what I mean, especially if the carbon is rigidly held by the holders. 2572

1288 x-Q. In the case of a carbon rigidly held by the holders, there are, as I understand you, two elements of danger to be guarded against: first, consumption of the carbons at the ends by the formation of an arc due to imperfect electrical connection or contact; and, second, fracture of the carbon at any point due to

2573 inequality of expansion and contraction of the carbon and its holders?

A. Yes; those dangers exist.

1289 x-Q. Now, this Patent, 205,144, in describing the device or mechanism for feeding the carbon rod down upon the carbon block, states "thus should fracture or a slight consumption of the carbon occur * * * * the necessity of taking down the same, renewing the carbon and re-charging the globe is obviated." Had you found, at the time of the applica-
2574 tion for this patent, that consumption of the carbon at point of contact with the holders had occurred in practice?

A. Yes; it did sometimes occur in some of our lamps; not always or usually.

1290 x-Q. Would the feeding mechanism of this lamp be effective in compensating for the fracture of the carbon pencil at any point other than at the point of contact between the pencil and the block D, or immediately above it?

2575 A. Yes, up to the part G, provided the pencil above was long enough to reach from G to the block below it.

1291 x-Q. Where, in actual practice, did you find that such fracture usually occurred in such lamps as are shown in this patent?

A. At the block D, or at the part G, but fractures were very rare in this form of lamp.

1292 x-Q. If fracture or consumption occurred the pencil E slid down through the pencil G on to the carbon D, and new contact was made, was it not?

2576 A. Yes.

1283 x-Q. Now the current came through the support G, did it not?

A. Mostly, but not entirely.

1294 x-Q. Now G was of metal, was it not?

A. No, I think it was of carbon usually, but I don't remember.

2577

1295 x-Q. The pencil E, being adapted to slip through the support G, did you find in practice that an arc was likely to occur at this point?

A. It sometimes did occur at this point, but was not very likely to occur there, inasmuch as the pencil throughout its whole length was a conductor, and above G carried a portion of the current which caused the illumination of the pencil below G, through which the whole current passed.

1296 x-Q. Now, the pencil E rested upon the block D, being held in position by pressure. Did an arc 2578
usually occur at this point of contact?

A. No, it did not usually occur at any point, but in lamps in which the carbon was not rigidly attached to D, it did sometimes occur at that point, but rarely.

1297 x-Q. Did D or G, or the part of the pencil which was inserted in G, or passed above it, become incandescent when the lamp was lighted?

A. No, it was not intended to do so, but in some of our lamps, before we got them adjusted, it sometimes happened that the upper part of the pencil above G was 2579
heated up to a dull red. This showed that the electrical contact at G was not sufficiently good, and the lamps were taken down and adjusted so that they would not heat above the piece G. I am confining my answers to lamps in which the part G was introduced, and have not referred to the other forms shown in the patent in which the part G was not used.

1298 x-Q. Now, a lamp which did not require this feeding mechanism, and in which the carbon conduc- 2580
tor could be rigidly held without fracture or consumption from the causes mentioned, would be much simpler in construction and more economical to make than the lamp shown in this patent, would it not?

A. Yes, than the lamp shown in Fig. 1 of that patent, and such a lamp is shown in Fig. 8 of the patent, and we made other forms much more simple of this kind that you speak of.

2581 1299 x-Q. Prior to filing the application for the patent?

A. Yes.

1300 x-Q. When you filed the application for this patent, had you made, or did you think there could be made, practically operative lamps employing a straight stick of carbon in which no feeding mechanism was required and where the carbon conductor was rigidly attached to its holders, and in which fracture of the
2582 carbon or consumption at the points of contact did not occur at so early a time as to make the lamp inoperative?

A. Yes, we had made such lamps, a good many of them, and of course I thought and knew they could be made.

1301 x-Q. Why then did you in your first patent describe a lamp in which this more expensive and inferior mechanism was employed?

A. Because we thought that if we did not cover the
2583 device of a feeder lamp by our patent others would do so, and we thought it desirable to patent the feeding feature of a lamp.

1302 x-Q. If, at the time you filed this application, you had, as you say, made lamps simpler and cheaper in construction, and equally efficient, and not having the defects which this feeding mechanism was designed to compensate for, why did you not patent them or the inventions of such lamps?

A. We did, in this very patent, or intended to do so,
2584 so far as the straight pencils are concerned.

1303 x-Q. Please point out where in this patent you have described lamps not employing the feeding mechanism, and not having the defects which the feeding mechanism was designed to compensate for.

A. Fig. 8 in the patent is an illustration of such lamp, and Fig. 8 is described in the patent.

1304 x-Q. Please read from the patent what you as-

sert to be a description of a lamp not employing a 2585
feeding mechanism, and not having the defects which a feeding mechanism was designed to compensate for.

A. "In Fig. 8 we have indicated a modification of "the single carbon lamp, the clamp G being dispensed "with, and the bent rod F being provided, like the rod "I of Fig. 1, with a carbon piece X wired to it pre-"cisely as carbon D is wired to rod I," and the whole of the carbon E is rendered incandescent, no part of it being reserved for feeding down upon the block D. 2586

1305 x-Q. And is what you have just read what you assert to be a description of lamps not employing the feeding mechanism and not having the defects which the feeding mechanism was designed to compensate for?

A. Yes, taken in connection with the rest of the patent, it is an illustration and description of a lamp of that character and is one form of lamps of that character which we made. In this case the part F simply acts as a compensating device for unequal expansion and contraction of the incandescent carbon 2587
and its holders.

1306 x-Q. Is there any statement in the patent that the modification in Fig. 8 does not employ the feeding mechanism which you have described in the patent.

A. There is an omission in Fig. 8 of any carbon to be fed and of any holder for a new carbon or part of a carbon to be fed (such as the part G) which amounts to the same thing. It would be unnecessary, it seems to me, to state that anything that was not a feeder lamp was not a feeder lamp; the drawing being part of 2588
the description.

1307 x-Q. All that I see in the patent concerning Fig. 8 is the statement that in Fig. 8 you have indicated a modification of the single carbon lamp, the modification being stated to consist in the omission of the clamp G, and in such case providing the bent rod F with a carbon piece X wired to it as the carbon is

2589
wired to rod I. Now, the single carbon lamp employed the feeding mechanism of the bent rod F sliding in the part H. Now what is there to indicate that after you had performed the modification shown in Fig. 8 that the rod F does not still slide in the part H?

A. There is nothing, but the total omission of a carbon to be fed, shows that it is not and cannot be a feeder lamp; again, the omission of any holder or receptacle for a carbon or part of a carbon to be fed,
2590 which is the office of the part G in Fig. 1, also shows that Fig. 8 is not an illustration of a feeder lamp. In Fig. 1 the part F exercises two functions, the first of which is to maintain electrical connection or contact between the carbon and its holders and compensate for unequal expansion and contraction between the incandescent carbon and its holders, the second of which functions is to feed a new part of the carbon down upon the block D in case of fracture or consumption. In the illustration Fig. 8, the rod F only serves in its
2591 function of maintaining contact and compensating for unequal expansion and contraction by the movement or sliding to which you refer.

1308 x-Q. You think then that Fig. 8, taken in connection with the description you have quoted, shows a lamp in which no feeding mechanism is employed?

A. Yes, and the absence of any method or attempt to introduce any compensation by which the electrical resistance of the lamp should be maintained the same or substantially the same, a function which the part G
2592 exercises in Fig. 1 further confirms me in that opinion.

1309 x-Q. Is there anything in the patent which states or indicates how in Fig. 8 the carbon E was held between the holders?

A. I think the illustrations, figures of the patent, show it. I don't remember whether it is referred to in the text or not.

2593

1310 x-Q. Well, please tell me how you think the patent states that the carbon E in Figure 8 is held?

A. Figure 8 shows that it is held between X and D. I don't know that there is anything further than that.

1311 x-Q. Is it rigidly and firmly held?

A. I do not know that there is anything in the patent to show whether it is rigidly held or simply kept in place by insertion into the parts D and A, and by the weight of F and X.

1312 x-Q. Now, the feeding mechanism of the lamp 2594
was, as we agree, to compensate for fracture of the carbon or consumption at the points of contact between the carbon and its holders. What is there in the patent or in any of the drawings to show that in the modification of Fig. 8 fracture or consumption would be avoided?

A. The movability of the part F, and the fact of its weight, the movability of the part F being a compensation for unequal expansion of the incandescent carbon and its holders, and the gravity of F acting to 2595
maintain the electrical contact notwithstanding expansion or contraction in the length of the incandescent carbon, differing from the expansion or contraction in the length of its holders.

1313 x-Q. Then the part F, in the modification of Fig. 8, does slide in the part H?

A. It does, as shown in the patent.

1314 x-Q. If in this modification, consumption of the carbon at the points of contact with its holders should occur, F would also slide in the slot H and pre- 2596
serve the contact?

A. Yes, and the arc being established, the resistance of the incandescent carbon would be reduced as its length was diminished, and in all probability the arc re-established by a greater current due to diminished resistance, and this process would be continued and increased and the carbon consumed.

2597 1315 x-Q. Would not that likewise occur in the lamp of Fig. 1?

A. Not to the same extent, the distance between G and D being maintained in the lamp of Fig. 1, the resistance of the lamp would remain more nearly constant and the arc would not be likely to be renewed, as the current mainly and almost entirely passes through G.

1316 x-Q. If, as you now say, the modification of Fig. 8 preserved the sliding of F in H, so that if there
2598 was consumption at the points of contact the carbon would be fed down, as would also occur if a fracture occurred in the carbon at or near the block D, how can it be true as stated in your 1302d answer that this patent, patented a lamp in which no feeding mechanism was employed and which did not contain the defects which feeding mechanism was designed to compensate for?

A. I say so, because we made such lamps; they were practical lamps without any feeding, and they
2599 were not feeder lamps, in any practical sense. If the carbons broke, or if an arc occurred it was a practical end to the life of the lamp of that kind.

1317 x-Q. If, as stated in your 1300th answer, at the time the application for this patent was filed you made and thought there could be made practically operative lamps employing a straight stick of carbon in which no feeding mechanism was required, and where the carbon conductor was rigidly attached to its holders, and in which fracture of the carbon or
2600 consumption at the points of contact did not occur at so early a time as to make the lamp inoperative, and inasmuch as the modification of Fig. 8 still employs the sliding of F in H, what explanation, other than as given in 1301st answer, have you to give for the description in this patent of this expensive and unnecessary construction?

A. I do not think any further explanation is re-

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quired; I remark that if one's foresight were as good as his hindsight, you would not now be asking me this question: but again, if further explanation is required, it will be found in the fact that this art was then new and substantially unpracticed, nevertheless, incandescent lamps and semi-incandescent lamps or feeder lamps had been made, or tried to be made, before that time. We did not know which would prevail; the present state of the art has after years and years, as it 2602
appears at present, answered that question; we did a great many unnecessary things without doubt, which under the light of the present day we would not have done.

1318 x-Q. Why did you not at this time describe or patent the lamp employing a straight stick of carbon held rigidly between its supports which did not require this complicated, expensive and useless mechanism?

A. I do not know that we did not do so. I think that some of the elements of this lamps which we patented are in the incandescent lamps of to-day. If 2603
we did not patent anything that we ought to have patented, it was perhaps due to the fact that my co-worker, Mr. Sawyer, was to pay all the expenses of obtaining patents, and desired to avoid all expense that he could in that direction, and alleged that when the company was formed (that was to be formed), patents could be taken out for less and minor things and details; it was largely due to this fact that more patents were not taken out.

2604

Adjourned till Tuesday, 25th inst., at 1 P. M.

2605 Tuesday, 25th October, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows:

1319 x-Q. The second patent granted to Sawyer and Man for an electric lamp is Patent No. 210,809, the application for which was filed November 5, 1878. Does not the lamp of this patent employ a mechanism
2606 to provide against expansion or contraction of the carbon, and by which mechanism, if the carbon were consumed by arcs at the point of contact between the carbon and the holders, contact would still be preserved by the holders approaching each other through the action of a spring?

> Objected to as incompetent, irrelevant, immaterial and not proper cross-examination; the patent referred to not being the patent in
> 2607 suit, and having nothing whatever to do with the issues in this controversy.

A. It contains the kind of mechanism which you mention, but not for all the purposes which you mention, nor would it practically so act; the object of the device referred to in the lamp was to provide for expansion and contraction, and make and keep good electrical connection between the incandescent carbon and its holders. It was not a feeding device; it would not practically so act, because when the electrical
2608 connection between the incandescent carbon and its holders were not sufficiently good to prevent an arc being formed between the carbon and its holders, the practical life of the lamp was ended.

1320 x-Q. In the lamp of this patent, was not the incandescent carbon held in position by the pressure of spring W acting upon the stirrup V, and was not the

operation of the mechanism as follows: Upon any expansion of the carbon additional pressure being exerted against L, the spring yielded before fracture of the carbon occurred; if the carbon contracted, contact was preserved by the spring pressing upon the holder L? 2609

> Same objection.

A. Your description of the working of the apparatus is substantially correct, but it does not wholly explain the working of this part of the apparatus. The ends 2610
of the incadescent carbon were in practice by us rigidly attached to the holders in most cases; were not so done, in the working of the lamp, they became so, soon after it was heated up. Now, if the holders were rigid and kept at a fixed distance from each other when the carbon was heated up it would be expanded in length, and if by compression at high heat it endured the strain of such expansion, when it was cooled off it would be shorter than the distance between the holders 2611
and would be pulled apart by contraction either at some point in its length or at its ends, breaking the elecrical connection.

1320½ x-Q. Is there anything in this patent showing or stating that the incadescent carbon was rigidly attached to its holders?

> Same objection.

A. No, but such was the fact of practice and such became the fact by use.

1321 x-Q. Now, if an arc in such a lamp as is shown 2612
in this patent should form at the points of contact between the carbon and its holders and the carbon at this point begin to consume, would not the spring operate to bring the holders nearer together until the carbon was consumed?

> Same objection.

2613

A. Yes, until the carbon was consumed or fell out of the holders, which would soon take place; the practical life of the lamp would ordinarily be ended when the arc was formed.

1322 x-Q. Now, did not the strength of this spring have to be adjusted with reference to the size and strength of the carbon conductor?

Same objection.

A. It did.

2614 1323 x-Q. In the lamp of Patent 205,144 the sliding mechanism had to be adjusted with reference to the strength and size of the carbon conductor?

Same objection.

A. Yes.

1324 -Q. Did you consider at the time you filed the application for Patent 210,809 that the spring mechanism of this lamp was superior to the sliding mechanism
2615 of the lamp of Patent 205,144 as avoiding fracture from expansion or contraction?

Same objection.

A. I cannot recollect, but I suppose that we did; I am confident of it so far as the lamp shown in Fig. 1 of Patent No. 205,144 is concerned, and I believe we did so far as the device shown in Fig. 8 of that patent is concerned.

1325 x-Q. Now, if at the time you filed the applica-
2616 tion for the Patent 205,144, some six months before this Patent 210,809 was filed, as stated in your 1300th answer, you had made practically operative lamps employing a straight stick of carbon in which no feeding mechanism was required, and where the carbon conductor was rigidly attached to its holders and in which fracture of the carbon or consumption at the points of contact did not occur at so early a time as to make the

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lamp inoperative, what was your reason for describing and claiming in this patent this spring mechanism for preventing fracture of the carbon?

Same objection.

A. I have already explained the difference between a feeding device and a compensation for expansion and contraction, and although some parts of the one may be employed in the other, they are not employed as feeding devices, nor have I intended to state that no compensation was introduced into our lamps for ex- 2618
pansion and contraction.

1326 x-Q. I do not wish any misunderstanding to occur. Now, in Patent 205,144 is shown and described a sliding mechanism, which, as the carbon lengthens or shortens, either yields or follows the shortening; in Patent 210,809 is shown a spring mechanism which gives as the carbon lengthens or follows it as it shortens; whatever other functions these devices may perform I understand we agree that they are intended to prevent or avoid fracture of the carbon due to its ex- 2619
pansion or contraction. Now, please tell me whether prior to the filing of the application for the Patent 205,144, on May 16th, 1878, you had made lamps and thought there could be made, lamps practically operative employing a straight stick of carbon in which no mechanism was required of the kind shown in either of these patents for providing against fracture of the carbon by its expansion or contraction, and where the carbon conductor was rigidly attached to its holders, and in which lamps fracture of the carbon or consump- 2620
tion at the point of contact, did not occur at so early a time as to make the lamps inoperative?

Same objection.

A. In nearly all of our lamps, substantially all, some expedient was used to compensate for and prevent the injurious effects of expansion and contraction of the

2621 incandescent carbons. sometimes one device and sometimes another. The sliding device shown in Patent 205,144, as applied to lamps of the form shown in Fig. 8 of that patent, relying simply upon gravity for that purpose, were deemed, at the time that patent was taken out, equivalent for all other forms, such as springs; we had made a few lamps at that time, and only a few, in which all the conditions existed which you state in your question; the carbons usually broke
2622 in these lamps at the second or third time they were lighted up; after that, some compensation was always introduced by us for contraction or expansion; I have reference now only to straight pencils, to which I understand your question to refer.

1327 x-Q. You say in your answer, that nearly all of your lamps employing a straight stick of carbon had some sliding or spring mechanism to compensate for expansion or contraction, and thus avoid fracture. You also say that you had made a few lamps having the con-
2623 ditions mentioned in my question, but that in these lamps the carbon usually broke at the second or third lighting. I do not understand from your answer whether at the time you filed your application for Patent 205,144, you had made lamps which you considered practically operative, employing a straight stick of carbon rigidly held to its supports, and in which no spring or sliding mechanism was required to compensate for expansion or contraction of the carbon, and in which fracture did not so early occur as to render the lamp
2624 practically inoperative; please tell me whether you had or had not at that time made such lamps?

Same objection.

A. I have stated the facts in regard to the matter and I do not desire in any way to seem by my answers to avoid explicitly answering your question; the few lamps to which I refer were practically operative dur-

ing their first lighting up, some of them during their second and probably their third lighting up; beyond that the carbons broke, and they were not further practical lamps; they were practical lamps to the extent only that I have stated; they were not enduring lamps beyond that extent. 2625

1328 x-Q. Did the fracture occur at so early a period in the life of the lamps as to render them, in your judgment, inoperative as lamps?

Same objection. 2626

A. No; they were operative to a limited extent, such as I have stated.

1329 x-Q. I cannot yet understand from your answers whether you had made lamps of the kind mentioned in my question 1326 which you considered practically operative as lamps?

Same objection.

A. Yes, practically operative, so long as the carbons 2627
were not broken, but not enduringly operative.

1330 x-Q. What I want to know is whether the carbon broke at so early a stage in the life of the lamp as to make the lamp practically inoperative as an incandescent lamp?

Same objection.

A. Yes, for those purposes and uses where a lamp was required to be used with the same carbon and in the same atmosphere, beyond its first, second or third 2628
lighting up. No, for those lamps whose requirement in use was only to be lighted up once, or at most twice or thrice, without putting in a new carbon and recharging the lamp.

1331 x-Q. Now, a lamp which was so made that the straight carbon pencil did not break and have to be renewed was superior to a lamp the same in other re-

2629 spects in which the pencil would break and have to be renewed?

Same objection.

A. Yes.

1332 x-Q. If such a lamp as is shown in Patent 205,-144, the carbon pencil would not break by reason of its expansion or contraction, and if an arc did not occur to consume it, the feeding or compensating mechanism would be entirely unnecessary and useless, would
2630 it not?

Same objection.

A. Yes; but it *would* fracture were it not for the compensating mechanism.

1333 x-Q. Did you then, at the time you filed the application for Patent 205,144, believe, and had your experience taught you, that a straight pencil of carbon used as an incandescent conductor would frac-
2631 ture by reason of its expansion or contraction, and that a compensating mechanism was necessary?

Same objection.

A. Our experience was that straight carbons held rigidly without compensation for expansion and contraction—that is, some device allowing them to expand or contract in their length—would be broken soon after, but not at their first lighting up, and we thought some compensating device allowing for such expansion and
2632 contraction highly desirable.

1334 x-Q. Sufficiently desirable to justify the additional cost of the compensating mechanism?

Same objection.

A. We thought it might be, and, I believe, we thought it was.

1335 x-Q. You began your experiments, you have

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said, by holding the carbon between two parallel holders. Did you ever devise a compensating mechanism for a straight piece of carbon so held?

Same objection.

A. Yes.

1336 x-Q. When you filed the application for Patent 206,144, did you consider the apparatus there shown as the simplist and most efficient compensating mech- 2634
anism you had them made where a straight stick of carbon was employed?

Same objection.

A. No.

1337 x-Q. Why did you describe in the patent this, when you had a simpler and more efficient one?

Same objection.

2635

A. Because Mr. Sawyer thought that the device shown in that patent was the equivalent of the other devices which we used, and we desired, or rather he did, to patent the feeder lamp feature of that patent, which showed at the same time the compensation for expansion and contraction.

1338 x-Q. When you applied for Patent 210,809 the spring mechanism there described the simplest and most efficient you had obtained for compensating for expansion and contraction where a straight stick of 2636
carbon was employed. This lamp, I understand you to have said, did not have the feeder principle?

Same objection.

A. At the time when the directions were given to the solicitor to apply for that patent, we deemed the compensating device shown in it the best, all things considered, and taken in connection with the other

2637 parts of the lamp for the purpose for which it was intended, not perhaps in all its details, but in its main features.

1339 x-Q. Did you at that time consider where a straight stick of carbon was employed a device compensating for the expansion and contraction of the carbon desirable?

Same objection.

2638 A. Yes, I think that we did.

1340 x-Q. Sufficiently so to justify the expense of the compensating mechanism?

Same objection.

A. I think that we did.

Adjourned till Wednesday, the 26th inst., at 1 P. M.

2639 Wednesday, Oct. 26, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows:

1341 x-Q. In view of the fact that a carbon conductor of such a lamp as is shown in Patent 205,144, had to support the weight of the sliding mechanism, and that the carbon conductor of lamp 210,809 had to re-
2640 sist the pressure of the springs, could a delicate, small carbon be used in lamps of the kind shown in these patents?

Same objection.

A. Not carbons of the smallest size in the first form 205,144. In 210,809, very thin and tenuous carbons could be used.

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1342 x-Q. What was the weight of the sliding mechanism in 205,144?

Same objection.

A. I cannot state. We made them of various sizes and weights. The weight of all was slight, unless in lamps where large carbons were used.

1343 x-Q. What was the pressure upon the carbon rods exerted by this sliding mechanism?

Same objection. 2642

A. Substantially the same as the weight of the sliding part F.

1344 x-Q. What was the lightest one you ever made or used in a lamp about?

Same objection.

A. I don't know, and I never weighed one. I can only express it by saying it was of very small weight.

1345 x-Q. Lighter than an ounce. 2643

Same objection.

A. A very small fraction of an ounce, I should think.

1346 x-Q. As light as the tenth of an ounce?

Same objection.

A. I don't know. I should think much less.

1347 x-Q. Less than the twentieth of an ounce, should you think?

Same objection. 2644

A. I don't know.

1348 x-Q. Was it made of metal?

Same objection.

2645

A. No, ordinarily we made them of carbon. Some were made of metal.

1349 x-Q. Now, where the carbon expanded the part F slid upward, pressed by the carbon, did it not?

Same objection.

A. Yes.

1350 x-Q. And when it contracted it slid down upon
2646 the carbon?

Same objection.

A. It slid down *with* the carbon, keeping in contact with it.

1351 x-Q. In view of these facts and in view of the fact that the pressure was not in the same line as the line of movement between the parts, but was exerted on a cross piece at right angles to the line of movement which would require a greater force to cause the
2647 parts to slide than if it were in the same line, can you not tell me what was the smallest carbon in length or cross-section which you used in an operative mechanism of this character?

Same objection.

A. Not from the data you give, but I can give my recollection in regard to the carbons that we did use. They were somewhat less than a twentieth of an inch in diameter ordinarily, and some of less diameter and
2648 of an ordinary length of about five-eighths of an inch in the incandescent portion, and some of slightly greater length.

1352 x-Q. What was the smallest carbon in cross-section you ever used in a mechanism of this character which would cause the parts to slide as it expanded or contracted?

Same objection.

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A. The smallest carbons, to the best of my recollection, used in such a mechanism, were from a thirty-second to a fortieth of an inch in diameter. It would not be right to say that these carbons by their expansion or contraction moved the sliding parts upon each other, the sliding motion being due more to the expansion and contraction of the sliding parts themselves and that due to the expansion and contraction of the incandescent carbon was almost infinitesimal in amount. 2650

1353 x-Q. Did not the carbon have to stand the strain necessary to cause movement of the parts, whether that movement was caused by the expansion and contraction of the holders or of the carbon?

Same objection.

A. Yes, in the one case as the fulcrum for the movement, in the other case as causing the movement.

1354 x-Q. You have given the diameter of carbons 2651
that would stand this strain and operate this mechanism as from the thirty-second to the fortieth of an inch. Now of carbons of this small size what was the greatest length of the incandescent part of the carbon that would so operate and work this mechanism?

Same objection.

A. About half an inch, according to the best of my recollection. Some were perhaps longer, but I cannot be certain of it.

1355 x-Q. The thinner the carbon, the shorter it 2652
had to be to work this mechanism; as you increased the length of the carbon, you would have to proportionately increase its diameter?

Same objection.

A. Yes.

2653

1356 x-Q. In such a lamp as is shown in Patent 210,809, what was the pressure of the spring there shown upon the holders?

Same objection.

A. Very slightly in excess of the weight of the lower block, which held the lower end of the carbon; as nearly the weight of that block as we could make it.

1357 x-Q. Now, what was the smallest carbon in
2654 cross section and greatest in length, that you ever used in a lamp of this character, in which the spring mechanism operated as designed?

Same objection.

A. I cannot at this length of time remember exact dimensions. The best of my recollection is, that we used carbons in this form of lamp as small as a sixty-fourth of an inch in diameter, but they may have been larger; but less than those we used in the other form
2655 of lamp. In length the longest, I should think, that we used, was two inches. Whether this length was of the smallest size of carbons or not I cannot recollect. They were less in diameter than the ordinary carbons that we used, and I think the nearest approximation would be a thirty-second of an inch in diameter. I think we used carbons of this small diameter of two inches in length, but at this length of time I would be unwilling to swear that they were so long; our ordinary carbons of the smallest size that we used were from half to
2656 three-quarters of an inch long. I am referring in my testimony to straight pencils.

1358 x-Q. Did you think at the time the application for the Patents No. 205,144 and 210,809 were respectively filed that they described operative mechanisms and practical lamps?

Same objection.

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A. Yes, I *knew* they did.

1359 x-Q. Now, on the 31st of March, 1880, you individually applied for a patent upon a lamp, upon which subsequently Letters Patent No. 227,118 were issued, a copy of which patent I hand you. In that patent you say: "Tension, torsion or compression upon the pencil acts in the end by continual repetition to destroy it." At the time you filed the application for this patent, were you still of opinion that a practical lamp could be made, in which tension, tor- 2658
sion or compression was exerted upon the incandescent carbon?

Same objection.

A. I do not recollect any impression in regard to it at the time. I think the statement in that patent is correct, that in the end, tension, torsion or compression operate to destroy the carbon, if other causes do not destroy it before it is destroyed by those things.
I knew before then that tension, torsion and com- 2659
pression had been so compensated for by us, that is, Sawyer and Man, that operative practical electrical lamps had been made and used by us.

Defendants' counsel offer in evidence U. S. Letters Patent to Albon Man for Electric Lamp, dated May 4th, 1880, No. 227,118 and the same is marked "Defendants' Exhibit Man Patent No. 227,118, October 26th, 1887." 2660

Exhibit objected to as incompetent, irrelevant and immaterial, having nothing to do with patent in suit and having no reference to anything mentioned in the bill or answer, and notice of motion is given to strike it out.

1360 x-Q. Now, on such lamps as were shown in

2661 Patents 205,144 and 210,809, tension, torsion or compression was exerted on the carbon pencil, was it not?

Same objection.

A. Compression was exerted in the lamp of the first patent to a very slight extent; but not tension or torsion. In the lamp of the second patent it might happen that tension or compression might take place to a very slight extent, and to this extent only, if the lamp was not in all respects properly adjusted. If
2662 properly adjusted, tension and compression were substantially eliminated, certainly sufficiently so to avoid any practically injurious effects therefrom. In neither form of the lamps was torsion exerted.

1361 x-Q. It would seem from this patent, that at the time you filed the application for the patent you regarded as a defect any tension, torsion or compression upon the incandescent conductor; was that your opinion?

2663 Same objection.

A. Not as stated. My opinion is better expressed by saying that such tension, torsion or compression as would end the life of the lamp before it would otherwise naturally be ended, was to avoided, if possible.

1362 x-Q. Well, you thought then, that these were defects, and that the extent of the defect was commensurate with the extent of the tension, torsion or compression; am I right?

2664 Same objection.

A. I don't remember to have thought in that way. I did think, in all probab lity, that it was desirable to avoid tension, torsion or compression, especially excessive tension, torsion or compression.

1363 x-Q. If then, when you filed the application for Patent 227,118 on March 31st, 1880, you regarded

any tension, torsion or compression on the incandescent conductor as a defect, were not the lamps of Patents 2665
205,144 and 210,809 defective in so far as they by their structures exerted compression on the conductor, and if lamps could have been made in which the straight carbon pencil never had any such compression upon it, would it not have been desirable?

Same objection.

A. First, I did not, then, to the best of my judgment, 2666
regard or believe that suitable tension or compression, such as the carbons would endure throughout their life without being destroyed as injurious, because it had no practical effect upon the life of the lamp; excessive or unsuitable compression or extension, such as would interfere with the life of the lamp before it would be destroyed by other causes, I must have regarded as injurious. The lamp of the Patent 205,144, I think had not as good compensation as the lamp of the Patent 210,809. Perhaps the lamp of the first patent might 2667
be considered defective in this particular, although we made many lamps of that kind that were good. The lamp of the Patent 210,809 was not defective in my judgment by reason of any excessive pressure upon the carbons, and my Patent 227,118 was taken out simply as another way, I thought, possibly, better and cheaper, to avoid pressure than the lamp 210,809. It is manifest that by removal of all pressure, tension and torsion, the danger of excessive pressure, tension and torsion is removed. It would, therefore, in that sense, 2668
be desirable to make lamps in which no tension, torsion or compression existed upon the straight pencil of the carbon. I am speaking here simply of tension, torsion and pressure in their effect upon the carbon, and not with reference to the use of pressure for any purpose in the lamp.

1364 x-Q. Now, let us see. Upon the carbon of

2669 Patent 205,144 there was a pressure equal to the weight of the entire upper holder. On March 31st, 1880, you applied for a patent in which you say, among other things, compression upon the pencil acts in the end to destroy it. Now, when you filed this application on March 31st, had you any opinion as to whether the pressure on the carbon in a lamp like Patent 205,144 was a defect which would destroy the pencil?

2670 Same objection.

A. No, I don't remember to have had.

1365 x-Q. Then this defect of pressure on the pencil, which in this late application you say would destroy it, was an imaginary conclusion of yours, and not the result of experience; or, in other words, you were speaking of a defect which you had not found to exist?

Same objection.

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A. No, that is not so. We had found that excessive pressure was injurious, and I was not speaking of any imaginary thing.

1366 x-Q. But you say excessive pressure did not exist in such a lamp as 205,144, and that a lamp like 210,809 was still better. Now, at the time you applied for this patent on March 31st, 1880, there had issued to Sawyer and Man two patents showing electric lamps. In each of these patents the lamps respectively shown
2672 are so constructed that there is pressure upon the straight carbon pencil, and it is by this pressure, or the removal of it, that the conductor is allowed to expand and contract, so as to avoid fracture. This patent of yours states that compression on the pencil will in the end destroy it. Now, I would like to know whether, at the time you filed this application, you considered the pressure necessarily exerted on the pencil

in such a lamp as 205,144 a defect, and whether, if you so thought, your opinion was based on experience with such lamps? If you did so think, please tell me? 2673

Same objection.

A. I do not remember to have thought anything about either of those lamps at the time of my applying for the Patent 227,118, and don't think I did, and my patent was not applied for to remove or remedy any defect in either of those lamps peculiar to them or because 2674
it existed in them. It was applied for by me because it was my own invention, belonged to me, and I thought it was a simple way of avoiding tension, torsion or compression upon a straight pencil—things which I had before then discovered might be injurious if excessive. The patent has always remained mine, and is mine to-day. I have never assigned it.

Adjourned till Thursday, the 27th inst., at 1 P. M.

2675

THURSDAY, Oct. 27th, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man proceeded as follows:

1367 x-Q. Then, as I understand you, you have never thought that if the lamps of these patents were properly made, the compression or pressure on the conductors was sufficient to be a defect of the lamp? 2676

Same objection.

A. No, not with carbons adapted to the lamps.

1368 x-Q. I understand the smallest carbons were not adapted to these lamps, or rather, these lamps to such carbons?

Same objection.

2677 A. No; not well adapted to the smallest carbons

1369 x-Q Am I correct in understanding that, according to Patent 205,154, the lamp of such patent had an atmosphere of nitrogen at ordinary atmospheric pressure?

Same objection.

A. The pressure of the gas in the lamp, as described in that patent, at the time of its sealing up was the
2678 same as that of the atmosphere, but as soon as it cooled off it was at less pressure than the atmosphere was, because in its passage through the heated tube for purifying it its temperature was raised and the gas in the lamp at the time of sealing up was hot, and at a higher temperature than after it had cooled off.

1370 x-Q. Was the heated gas passed through the lamp sufficiently long before sealing to heat the lamp to near the temperature of the gas?

Same objection.

2679

A. Yes, the lamp itself became warm.

1371 x-Q. As I read this patent, you state, that in a lamp containing an artificial atmosphere at atmospheric pressure, when the conductor was run to incandescence the heat generated would cause expansion of the atmosphere tending to force it out of the lamp, and upon the current being turned off and the atmosphere cooling, air from the outside would rush in and therefore a tight seal would have to be made?

2680 Same objection.

A. The statement contained in the patent, is a statement of what we understood the facts to be before our work. The inference which you draw from this statement is perhaps correct. The lamp should be tightly sealed.

1372 x-Q. Had you found that when the lamp was

not tightly sealed the atmosphere would be forced out 2681
when the lamp was run to incandescence, and atmospheric air come in when the current was turned off?

Same objection.

A. I do not recollect any such finding. It is manifest that such would be the case if the atmosphere of the lamp were at atmospheric pressure and the same temperature as the air, before it was heated up by the 2682
current or incandescent carbon.

1373 x-Q. You say in this patent, "As a safe-"guard against an infinitesimal leakage we prefer to "place in our lamps a small quantity of sodium, potas-"sium or other agent having a great affinity for oxygen," and claim doing so in the 17th claim of the patent. At the time you filed the application for this patent, did you prefer placing in your lamps a small piece of sodium, potassium or other agent having a great affinity for oxygen?

2683

Same objection.

A. Yes, I think so.

1374 x-Q. Was the object of this sodium or potassium to absorb any oxygen that remained or got into the lamp?

Same objection.

A. It was.

1375 x-Q. Had you found that oxygen got into the 2684
lamps after their sealing?

Same objection.

A. Yes, I think we had in our earlier lamps, before the lamp of this patent, or rather before the method of sealing up the lamp described in this patent was adopted by us.

2685 1376 x-Q. In lamps such as are shown in this patent, had you found, up to the time of filing the application, that oxygen got into the lamp chamber?

Same objection.

A. No I do not remember that we did, other than oxygen or air set free in the lamp chamber after it was charged from the walls of the lamp and its interior work, and I do not remember any trouble from oxygen so set free in lamps of the character of those in
2686 this patent; I think we had got rid of that difficulty before these lamps were made.

1377 x-Q. Then at the time you filed this application did you know that in a lamp, such as is described in this patent, and properly made, there was no necessity or use in placing sodium or potassium in the lamp?

Same objection.

2687 A. No, I do not think we *knew* that there was no use in doing it. We introduced it as the patent says as a safeguard in case the lamps were not properly sealed and the workmanship absolutely perfect, or nearly so, against, as we say, "infinitesimal leakage." I believe that we at times thought that it would not be necessary to put sodium or potassium in lamps well and perfectly made and sealed but, as absolute perfection of workmanship and manipulation could not be obtained, it was well to put it there, and we thought
2688 that its use might be valuable as an independent thing in lamps of any kind made by ourselves, or others, in which the construction was not so nearly perfect as to avoid infinitesimal leakage; we, therefore, patented it as a precautionary expedient.

1378 x-Q. But you know that in a lamp made according to the description of this patent, where the

best and most skillful workmanship was employed, this was entirely unnecessary? 2689

Same objection.

A. I do not think, and I have said that I did not think, that at the time we knew "it was entirely unnecessary," but we believe it to be so; we believed that it was not necessary in such perfectly constructed lamps.

1379 x-Q. The patent also says, "as an additional "safeguard we prerer to place in our lamps a quantity 2690
"of freshly burned lime" as an absorbent of carbonic acid gas, and in the 16th claim of the patent this idea is claimed; why was this lime put in the lamps?

Same objection.

A. By reason of its higher affinity for carbonic acid gas than sodium or potassium has.

1380 x-Q. What was the desirability of an absorbent of carbonic acid gas in the lamps? 2691

Same objection.

A. To purify the atmosphere of the lamp from that gas and keep it pure.

1381 x-Q. Where did the carbonic acid gas come from?

Same objection.

A. It might come from two or three sources; it might be with the atmosphere with which the lamp 2692
was charged, or the interior walls and works of the lamp, and be gradually freed in the latter case by diffusion, or it might come from union of the oxygen of any infinitesimal portion of air that should get into the lamp, or be left in it, combining with the carbon of the incandescent conductor when highly heated up.

1382 x-Q. At the time you filed this application

2693 what had been your experience; did these things, or any of them, occur which you mention, and have you found that carbonic acid gas was present in the lamp chamber?

Same objection.

A. Yes, prior to the filing of the application we had found carbonic acid gas in the chambers of our lamps and traced its source, as we thought, as I have stated
2694 in my last answer.

1383 x-Q. Did you, then, when you filed this application, consider it important to place lime in the lamp chamber?

Same objection.

A. I do not know that I could state it so strongly as that; we considered it sufficiently desirable, as an expedient and precaution, to patent it.

1384 x-Q. If, in practice, no carbonic acid gas was
2695 present in the lamp chamber this lime would perform no useful function; what I would like to know is whether, when you filed the application, you believed carbonic acid gas would be developed in the chamber, and, therefore, thought it would be useful, or whether you believed no such carbonic acid gas would be present, and therefore thought it useless. Which was the case?

Same objection.

2696 A. Neither; we knew that in all probability oxygen in some proportion would be in these lamps, as it is in those of to-day; that that oxygen would sooner or later unite with the carbon of the incandescent conductor and form carbonic oxide or carbonic acid gas, for which freshly burned quicklime would have a very high affinity and would take it out: Now, the practicability of a lamp would depend upon the amount of

this oxygen; lamps with an atmosphere containing so 2697
high a percentage of oxygen, or subsequently receiving it, as to be impracticable by reason of their short life might be rendered more practicable by the absorption of that oxygen and by the absorption of the carbonic acid formed from it, if the atmosphere of the lamps was sufficiently good, no lime was needed; we, therefore, as I said, patented it as an expedient or precaution.

1385 x-Q. I am not asking about hypothetical lamps, 2698
but lamps made in accordance with this patent. Now, when you filed this application, did you think it was necessary to put lime in the lamps, or did you not think it was necessary, or had you no opinion whatever on the subject?

Same objection.

A. I have not talked of hypothetical lamps. I have spoken of the atmosphere of this lamp and all other 2699
lamps. I do not think that in a properly constructed lamp, made upon the plan of this patent, we, at the time, deemed it necessary to use quick lime in them; I believe that we thought and knew that in some lamps freshly burned quick lime was useful. The fact is, that we found quick lime useful in some lamps that we made before this form of lamp: we did not, to the best of my recollection and belief, find it necessary in this lamp when properly constructed and charged.

1386 x-Q. It is stated in the specification of this Patent, 205,144:

"It has been found practically impossible, 2700
"under the varying degrees of heat and pressure, to maintain perfect joints, and the result "is that expansion of the artificial atmosphere "by the heat from the luminous conductor "expels a portion of the same, and constuction of the atmosphere upon cooling off

2701 "causes a portion of the external air to pen-
"etrate the globe, thus supplying oxygen,
"which at the next lighting feeds upon the
"carbon."

Later on the specification says:

"To guard against great heating and une-
"qual expansion at the joints, which would
"imperil the lamp and soon render it useless,
"we isolate the incandescent carbon from the
2702 "lower part of the globe where the joints are
"situated by a disk or diaphragm of some
"refractory substance, preferably soapstone
"or porcelain, whereby we prevent all down-
"ward radiation of the heat and keep the
"joints comparatively cool at the same time
"that the upper part of the globe may be
"very hot.

"Furthermore, to prevent conduction of
"the heat from the incandescent carbon to
2703 "the joints by the metallic connections
"communicating therewith, we arrange the
"two conductors leading upward from the
"base in a spiral volute, or fluting form, so
"that we obtain considerable length of con-
"ductor in a limited space and very little of
"the heat reaches the base."

Now, when you filed this application, did you consider this sopstone disk necessary on such lamps as are shown in this patent?

2704 Same objection, and the further objection that it does not appear by the question what lamps are referred to as containing the defects mentioned in the first part of the matter quoted from the specification, whether of the lamp of the patent or lamps that had gone before.

2705

A. The lamps constructed as those shown in this patent are, were run by us to an extremely high incandescence; much highet and giving much more light than the ordinary incandescent lamps of to-day—several times the candle power now ordinarily employed; we used the large currents, and this high incandescence because at the time we considered it highly desirable in our incandescent electric lamp. In such lamps run to the high incandescence I have spoken of, 2706
much greater heat was developed than in the lamps of to-day. I believe that at the time we thought this high incandescence and great light necessary to the introduction of incandescent electric lighting. To provide against the effect of this large heat, the devices of which you have spoken, were introduced by us into the lamp. I believe we considered them necessary under the circumstances of use which I have stated.

1387 x-Q. You say you believe you considered them necessary. Was this opinion theoretical, or had you 2707
found that where the disk was not employed perfect joint could not be maintained. I am speaking, of course, of lamps of this patent?

Same objection.

A. We found that the use of the disk and of the long conductors, or conductors formed specially to radiate heat, prevented heating of the base of the lamp, and that perfect joints could be maintained by their use. In lamps where they were not used, the 2708
bottoms of the lamps became hot, and leakage did occur there sometimes, and sometimes breakage, when run up to high incandescence, as we ran the lamps.

Adjourned till Monday, the 31st inst., at 1 P. M.

2709

NEW YORK, Nov. 7th, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man proceeded as follows:

1389 x-Q. On May 31st, 1878, you filed an application for an "Improvement in Electric Lighting Systems," which application resulted in Letters Patent No. 205,303. This patent was re-issued on an applica-
2710 tion for re-issue filed May 14th, 1881, and June 6th, 1882, and is Re-issued Letters Patent, 10,134. These patents cover a device by which the current is gradually turned on to the lamps. Did you think it important to turn the current gradually on to your lamps?

Same objection.

A. With the larger size carbons, yes; and where the lamps were filled with gas at atmospheric pressure, or
2711 near that with any sized carbon.

1390 x-Q. In lamps such as are shown in patent 205,144, was it necessary to turn the current on gradually?

Same objection.

A. I can only give the same answer as I did before, and add that we did not endeavor to preserve a vacuum in those lamps that I remember, and finally sealed up for use while we were at 43 Centre street.

2712 1391 x-Q. Question repeated.

Same objection.

A. I can only repeat the answer as I have given it to that question, and say that with the conditions under which the lamps were used at 43 Centre street, yes; when filled with nitrogen gas, yes.

2713

1392 x-Q. Is this a correct statement?

"In lighting a lamp such as that shown and described in Letters Patent 205,144, we found it important to turn on the current gradually."

A. We did find it important to turn on the current gradually, because we were using a lamp filled with gas.

1393 x-Q. Why was it important? 2714

Same objection.

A. Because the carbon was sometimes broken when the current was turned on full force suddenly.

1394 x-Q. At the time you applied for a patent on this Switch Patent 210,142, did you consider its use necessary for your lamps?

Same objection.

A. I do not remember. I knew we thought it 2715
important in this system of electric lighting.

1395 x-Q. You have been interrogated as to the very first experiments performed by you and Mr. Sawyer, with reference to paper and fibrous carbon. The last experiment you described was the taking of a slip of paper soft and porous, filling it with plumbago, pressing the plumbago into the paper and burnishing it, and then attempting to run a current through. What was the next experiment with paper or fibrous material? 2716

A. The next experiment was filling the paper with graphite by soaking it in water in which graphite was suspended, drying it and repeating until it was well filled with the graphite or plumbago, rubbing it in the paper after dry, burnishing it and pressing it in and then using the slip of paper thus prepared in a lamp or the incandescent portion of an electric lamp, endeavoring to carbonize the paper by the heat produced by the

2717 current while in an inert atmosphere used to prevent consumption.

1396 x-Q. Do you remember the size or kind of paper used for that purpose?

A. I think in these first experiments we used ordinary white blotting paper, as to size I cannot recollect. I should think, however, perhaps an eighth or tenth of an inch in width, the thickness of from one to three sheets of the blotting paper, a total length of three-
2718 quarters of an inch to an inch between the holders when placed in the lamp about an half inch, perhaps more.

1397 x-Q. In this case was the paper merely used as a support or holder for the plumbago or graphite?

A. No, the intention was to carbonize the paper. We had used pencils of graphite before.

1398 x-Q. Did you get a current through this piece of paper?

A. Yes.

2719 1399 x-Q. What happened?

A. It was heated up and carbonized and broken, as we thought, by the shrinkage due to carbonization.

1400 x-Q. What was the next experiment?

A. We soaked the same kind of paper in different mineral salts and partially reduced the salts, so as to make an electric conductor, using them in the same manner as we used those filled with plumbago. We heated them up by the passage of the current and carbonized them, but not with as good success as with the slips filled with plumbago. In neither case did the
2720 carbons produced last before breaking but a moment or two. Those filled with plumbago lasted the best, and the carbons aside from breakage seemed to be of good quality.

1401 x-Q. What were the mineral salts to which you refer, and how did you reduce the salts?

A. Two of the salts which we used, or tried to, were

nitrate of silver and acetate of lead. Perhaps we used 2721
others—I don't recollect. I forget what reaction we used to reduce the salts, probably in the case of the lead the reaction of sulphuretted hydrogen or hydrogen. We did very little of it, however.

1402 x-Q. As I understand you, after soaking, the paper was allowed to dry, and the object of this treatment was to have the paper absorb the mineral salt in order that its resistance might be reduced so as to enable you to force a current through? 2722

A. Yes.

1403 x-Q. What was the next thing you did?

A. The next thing we did, that I recollect, was to carbonize the paper in a close iron vessel covered with powdered carbon or plumbago in a furnace.

1404 x-Q. Until you carbonized paper or fibrous material by the heat of a fire, do I understand that you had not succeeded in getting a conductor in which paper or fibrous material was employed that was good 2723
for anything.

A. No. Rather, up to the time when we carbonized the paper in a furnace in a closed box we had not succeeded in making a practical conductor for an incandescent electric lamp out of the fibrous or textile material. We had only succeeded in producing a carbon suitable for the purpose of such a conductor, but which broke in the process of making it. We practically could not carbonize with the current as we used it. We thought, however, at the time, that holders might be devised by which the operation might be ren- 2724
dered practical, but we did not go further in that direction; at least I have no recollection of it. We simply succeeded in producing a good quality of carbon, not a good illuminating conductor; with the mineral salts we did not get a good carbon.

1405 x-Q. What information or suggestion had you

2725 derived from these experiments which induced you to try carbonizing by fire?

A. We had discovered that the paper made a good quality of carbon.

1406 x-Q. Had you discovered whether it would make a good incandescent conductor?

A. I don't know; we thought it might.

1407 x-Q. What is your best recollection as to how long it was after you went to Centre street that you first tried the carbonizing of fibrous material or paper
2726 by fire.

A. I cannot recollect; but taking everything into consideration, an approximation to it would be two or three weeks after we went there. It might have been earlier.

1408 x-Q. Please tell me where you got the iron box in which you did your first carbonization, what material you carbonized, what were the sizes and shapes of the material, where they were put into the box, and
2727 where the carbonization was done?

A. The iron box was one got by Mr. William Sawyer, father of William E. Sawyer. It was adapted to use from some piece of iron, I think, that he got from some of the shops at 43 Centre street. The material carbonized, to the best of my recollection, was ordinary blotting paper and card paper, or drawing paper. Some of the sheets cemented together in several thicknesses; the pieces carbonized first, I think, were flat sheets an inch or two square. The box was filled by old Mr. Sawyer and myself at 43 Centre street, and
2728 was clamped or wired up after being filled with the powdered carbon and the paper to be carbonized, and then taken by me to my house, 118 Putnam avenue, Brooklyn, and carbonized in my kitchen range.

1409 x-Q. Now, first as to the size and character of the box. Please give me, as near as you now recollect, the dimensions of this box, stating the thickness of

the iron, the kind of iron, and how the box was closed or fastened? 2729

A. I think it was a piece of cast-iron, with flat ends, with a hole through it lengthwise, from the best of my present recollection, about three inches in diameter. Its outside was, I think, irregular in shape, leaving the thickness of its walls uneven; I should say an average of about one-half or three-quarters of an inch. The ends were closed, making it a box by flat pieces of iron. My impression is that they were of wrought-iron, but they may have been cast, and the ends in its first use 2730
were, I think, fastened on by wires around the whole thing. I don't pretend that I can recollect with accuracy with regard to this thing such details as you ask me. I simply give the best and only impressions I have in regard to it. I testified in regard to this matter in the interference case between Edison and Sawyer and Man several years ago, when my recollection in regard to the matter was perhaps better than at present. I think that testimony is correct.

Adjourned till Wednesday, the 9th inst., at 1 P. M. 2731

New York, Nov. 9th, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows:

1410 x-Q. What, as near as you remember, was the length and diameter of this box? 2732

A. Outside about 4 inches in width or diameter; inside about three inches in diameter; the length of inside from open end to open end, I should think about two or two and a half inches—it might be three inches.

2733
1141 x-Q. How were the pieces of paper and powdered carbon put into the box?

A. First a layer of powdered carbon put into the box, which was leveled off, smoothed down and pressed level with a follower, then a layer of paper laid on top of this powdered carbon, then another layer of powdered carbon smoothed down, leveled off and packed, then a layer of paper on top of this, then another layer of carbon, another layer of paper and another of
2734 carbon, until the box was filled. On top of the last layer of paper, powdered carbon packed in until the box was completely filled, and the powdered carbon rose a trifle higher than the top of the box. The covering piece was then put on, pressed down upon the upper open end of the box to close it, and pack in the carbon. The whole was then taken and bound together with wire.

1412 x-Q. Had the paper been treated in any way?

A. No, except where more than one thickness of pa-
2735 per was used; in that case sugar, molasses or treacle was used between the layers of paper, and they were pressed and dried. I do not know, but we may have compressed the other paper before putting it into the box. I do not recollect; we sometimes did so.

1413 x-Q. Was the sugar, molasses or treacle used as a glue solely?

A. Yes.

1414 x-Q. This box, I understand, you took home and placed in the fire of your range?

2736 A. Yes.

1415 x-Q. What was the make of range in your house?

A. It was a McCann range.

1416 x-Q. What, about, was the size of the fire box?

A. As near as I could judge (I never measured it) about twenty to twenty-two inches long by nine or ten inches in width, and about fourteen inches in depth.

2737

1417 x-Q. What sort of fire did you use?

A. Coke fire.

1418 x-Q. How long did you leave the box in the fire?

A. I cannot recollect; until the whole thing was heated up as high as I dare to heat it, for fear of melting the box, and kept hot for a considerable time, perhaps half an hour, more or less.

1419 x-Q. Did you sit and feed the fire with fresh fuel? 2738

A. I think so. I know I stayed and watched it until I thought the carbonization was complete.

1420 x-Q. Had you ever carbonized anything before?

A. No, I do not recollect.

1421 x-Q. You say you kept it in the fire until you thought the carbonization was complete; what fact, in your mind, determined this question?

A. I do not know of any fact further than it had been heated up to a bright red heat for a considerable 2739
length of time.

1422 x-Q. By considerable length of time what did you mean?

A. I kept it red hot half an hour, more or less.

1423 x-Q. Did you then take the box from the fire?

A. Yes, I took the box off.

1424 x-Q. What did you do with it?

A. I think I put it in the hot ashes under the grate, covered it up and shut up the range, and left it there till the morning. The work was done that evening. 2740

1425 x-Q. As I understand then, the box was in the fire a sufficient length of time to enable it to become red hot, and was kept red hot for half an hour?

A. I should judge so.

1426 x-Q. Was the box heated to a red heat as rapidly as your fire could be made to heat it, or gradually?

2741 A. I do not recollect. I do not think it could be immediately so heated up.

1427 x-Q. Did you open your box at your house next morning, or did you take it to Centre street?

A. No; It was fused together, or the bindings were so fused to it that I could not open it.

1428 x-Q. Where was the box opened?

A. At the workshop, 43Centre street, by old Mr. Sawyer.

2742 1429 x-Q. Were you present when it was opened?

A. Yes.

1430 x-Q. How was it opened?

A. I don't recollect; I suppose with a file and cold chisel.

1431 x-Q. You had to cut or file the wires that were wound round the box, had you not?

A. Yes.

1432 x-Q. Were the tops or ends fused to the sides or walls of the box?

2743 A. No; I should think that they were, perhaps, slightly welded; at all events, they were adherent to the box, so that they had to be pried off or wedged off with a cold chisel, after the wires were cut, or one of them, at least, had to be so pried off or wedged off; I think the other was left on.

1433 x-Q. Do you remember whether it took some time to open the box?

A. A few moments only, I should think.

1434 x-Q. Who took the carbons out of the box?

2744 A. I don't recollect; probably I did it myself, or I and Mr. William E. Sawyer.

1435 x-Q. In what condition did you find the paper that had been put into the box?

A. Some of the pieces were nicely carbonized, and intact. If I recollect correctly, some of the pieces near the open ends of the box were partially consumed at their edges.

1436 x-Q. Did you notice any difference in carbonization between the blotting paper and the card board?

2745

A. I do not recollect to have noticed any.

1437 x-Q. Did you notice any difference between the carbonizatio of the pieces that had been glued together and the pieces that were not?

A. I don't remember any; they were thoroughly carbonized.

1438 x-Q. Had you ever seen carbonized paper before?

A. Yes. 2746

1439 x-Q. Where, and when?

A. I do not recollect; I had often seen it.

1440 x-Q. For what use was it intended?

A. I do not know that any use was made of it. It was carbonized for other operations than those for the production of carbon.

1441 x-Q. What did you do with this paper that you carbonized at your house?

A. We cut it up and used it for the incandescent conductor in our lamps. 2747

1442 x-Q. How did you cut the sheets?

A. I don't know whether with scissors or with knife.

1443 x-Q. Did you break many sheets in cutting?

A. Yes.

1444 x-Q. Who did the cutting?

A. I think mostly Mr. William E. Sawyer; he was most skillful at it.

1445 x-Q. Were you present when the cutting was done? 2748

A. Some of it.

1446 x-Q. About how many sheets were taken from the box?

A. I cannot recollect; I should think eight or ten, or more.

1447 x-Q. How many conductors did you succeed in cutting from the sheets?

2749

A. Only a few; perhaps a dozen or twenty, perhaps not so many.

1448 x-Q. Were they cut at the same or at different times?

A. They were cut at different times.

1449 x-Q. Were they all cut before any further carbonization was done?

A. That I don't recollect; I should think not.

1950 x-Q. You say you run some of this carbonized paper to incandescence, do you remember the dimen-
2750 sions of the first conductors you used, or whether they were cut from one sheet or several thicknesses, of from cardboard or blotting paper?

A. I do not remember definitely in regard to the matter, further than this, that we used up all the carbons which we had made, in our lamps, of all the kinds that we first made; the impression I have is that the thickest carbons were the ones we made most use of and found most successful. I could now state the size of carbons or their length to distinguish these
2751 from others that we used.

1451 x-Q. Inasmuch as you had to cut the carbons from the sheets of carbonized paper and could have cut them in any size you desired, and inasmuch as upon the size of the carbon would depend their resistance and the amount of current which would be required to run them to incandescence; and inasmuch as the resistance, the carbons and the quantity of the current required must have had direct relation to the generators of electricity you used, can you give me no idea of the
2752 dimensions of the carbon conductors you cut from the paper? You will bear in mind also, that the size and shape of these carbons must have had some close relation to the kind of lamp in which you tried to use them?

A. From the considerations spoken of by you, and from others and possibly from recollection, I proceed

2753

to give you my idea of their size and shape. First as to shape. I think these first paper carbons were all cut into straight strips and into low, flat arches, the carbons were too tender to stand pressure between holders and were stretched across tops of the holders in the lamps, their ends resting in slits cut in the tops of the holders. Between the holders the distance was varied from a quarter of an inch to half an inch, or possibly five-eighths; this gives the lengths of the incandescent portions of the carbon; their width was various, 2754
as I should say now from a twelfth of an inch or less up to three-sixteenths, possibly a quarter of an inch; their thickness was the thicknesses of the carbon of the paper from which they were made; some of these first paper carbons, I think, may have been bent flatwise, forming an arch rising above the holders, the ends of the arch resting upon the tops of the holders in a slit or slits made to receive them; or upon a ledge cut on the inner faces of the holders upon which their ends rested, and held in place by the spring of the 2755
carbon. I am not positive as to any of the these firs carbons being used in this last way, but I think it possible they were.

1452 x-Q. As I understand you, the lengths of the carbons were from a quarter of an inch to three-sixteenths of an inch; their width from a twelfth of an inch, or less, to half an inch, and their thickness the thickness of the sheets from which they were cut?

A. This is in accordance with the idea I wished, except as to length. I spoke only of the incandescent 2756
portion of the length of the carbon; to this should be added the thickness of the two holders, perhaps six-sixteenths of an inch to make their total length.

1453 x-Q. I assume these experiments were conducted with some intelligent purpose; if this be so what was your object in making conductors from the paper which you carbonized?

2757

A. Our object was to get a good and cheap, readily made incandescent conductor and this was one step in the process.

1454 x-Q. Good in what respect?

A. Of pure carbon, and so able to withstand the intense heat of the incandescent lamp conductor.

1455 x-Q. Before carbonizing the paper you knew it could be carbonized?

A. Yes.

1456 x-Q. That if carbonized it would be substan-
2758 tially a pure carbon?

A. Yes, if made of the right kind of paper.

1457 x-Q. That when the sheets or mass were carbonized you could cut from them conductors of such shape as desired?

A. No, we did not know that, but we thought it probable and worth a trial, and we did not know that if we could cut the paper carbons into the size and shape which we desired for incandescent conductors,
2759 that they would then have sufficient coherency and strength to be used as such incandescent conductors, or whether they would have other properties necessary or desirable in such conductors.

1458 x-Q. By other properties, to what properties do you refer?

A. Density, durability, elasticity, capability of expansion and contraction without fracture, suitable conductibility or resistance, and the like.

1459 x-Q. I am anxious to understand the object you had in view when making conductors from carbon-
2760 ized paper the first time. You say you knew that paper could be carbonized and that if proper paper were used, a reasonably pure carbon could be obtained, but that you did not know positively whether a conductor could be cut from a carbon sheet, or whether the carbon when cut would have requisite consistency and strength to hold together under the effect of the current running to incandescence or to be handled and

put into holders. Now please state the object you had 2761
in view in this first experiment?

A. In the first place, at that time it was extremely difficult to get any pure carbon at all suitable for an incandescent conductor. That we had obtained was difficult and expensive to work and get into shape and size; again, we thought it was not all that was desirable in many respects, such as I have mentioned above and enumerated for such conductor; we thought we might get a good conductor, so we then looked upon
it, from the carbonization of paper. I do not think 2762
we went into any refinements in regard to it, such as as would be considered in the present day, or such as we afterwards came to consider in the manufacture of incandescent conductors. In using the word good conductors I used it only in the sense in which we looked upon it at that time, without going into the particulars or details of the matter, and without pretending that our ideas at that time were definite or fixed as to the best conductor. We knew some properties and
some things which we thought desirable, and if it fell 2763
in with those we would think it a good conductor, if it proved in our use practical.

1460 x-Q. Had you any preference at that time for a low or high resistance in the carbons, assuming the carbons to be of the same size and shape?

A. I do not know what you mean by a low or high resistance; if you mean relative resistance I can answer the question.

1461 x-Q. What I wish to know is whether at the 2764
time you carbonized this paper first, you had any preference for a low or high resistance in the carbon, due to its character or construction and not dependent on its size or shape?

Question objected to as being one which is impossible for the witness to answer; the question of high and low resistance being

2765 purely comparative and undetermined; impossible for the witness to know what is meant by the question and by the expression high and low resistance.

A. I cannot answer that question unless you state to me what you consider in the question a high and what a low resistance. If you ask the question, substituting the words lower for low, and higher for high,
2766 I will answer it.

Adjourned till Nov. 10th, at 1 P. M.

NEW YORK, Nov. 10th, 1887.

Met pursuant to adjournment.

2767 Present, counsel as before, and the cross-examination of MR. MAN continued as follows:

1462 x-Q. Is it not true that carbons of the same dimensions differ in their electrical resistance due to the difference in structure or character of the carbons?

A. It is.

1463 x-Q. At the time you made this first experiment, had you any preference for a carbon having a higher resistance over a carbon having a lower resistance?

2768 A. Within certain limits I had. Mr. Sawyer had a decided preference for the higher resistance kinds of carbon, perhaps I should say that it was his opinion at the time that the higher resistance carbons within practical limits of resistance were, or would prove the best carbons for the incandescent conductor of an electric lamp. My own opinion on the subject at the time was not fully formed, and I may say that it was a ten-

tative opinion, that greater conductibility or less resistance in the carbon would be desirable for the incandescent conductor of an electric lamp, than Mr. Sawyer thought. 2769

1464 x-Q. Do I understand, then, that you and Mr. Sawyer differed then, as to the desirability of a higher or lower resistance in carbons of the same size and shape?

A. Yes; I think we were not agreed.

1465 x-Q. In trying this first experiment in carboni- 2770
zation of paper, had you present in your mind the getting a higher resistance in the carbon due to the character and construction of the carbon?

A. I do not think we had, as a separate thing.

1466 x-Q. Then the object of this experiment was to ascertain if you could get a pure carbon, which would hold together under the effect of the current, which was strong enough to be put into the lamps, and which would last well with the current you were then using, 2771
and which could readily be made of any desired shape or size?

A. Yes; I do not recollect now any other purpose we had in mind at the time, but I do not mean to say that other things may not have been thought of by us but I do not recollect any others.

1467 x-Q. You say from the first paper carbonized, you succeeded in cutting from twelve to twenty pieces, which you tried as incandescent conductors; did you cut the pieces to correspond in shape and size to other 2772
conductors you had used?

A. Some of them substantially so, others not at all so; I refer to those that were bent flatwise in the shape of arches, rising above the tops of the holders; we had used none of this kind before, and they all differed in the manner of their connection with the holders.

1468 x-Q. Had you ever before tried to run to in-

2773 candescence a conductor as thin as a conductor made from a single sheet of paper carbonized?

A. I do not remember any, except the paper filled with plumbago.

1469 x-Q. Do you refer to the experiment concerning which you have previously testified?

A. Yes. It may be, however, that some of the carbons made from sheet French carbon and worked down, may have been as thin as the single sheet paper carbon.

2774 1470 x-Q. Did you succeed in running any of the carbons cut from the sheets of paper carbonized in your first experiment, to incandescence?

A. Yes.

1471 x-Q. All of them, or only some?

A. Only some of them; some of them were of too high a resistance for the current from our dynamo; they were cut too narrow.

1472 x-Q. Which of the carbons could you run to incandescence?

2775 A. Those of least resistance.

1473 x-Q. And which were they?

A. Those of the largest cross section, those that were thickest or widest, or both.

1474 x-Q. Did you find that the larger the carbon the more brilliant its incandescence?

A. Yes, within certain limits.

1475 x-Q. You say some of these carbons were of approximately the same dimensions as those you had previously used; which were they, those cut from the sheets of blotting paper glued together?

2776 A. Some of them were, and some of them from the single sheet of drawing, or blotter, or card.

1476 x-Q. Did you notice any difference between the incandescence of those carbons, corresponding in size and shape, to carbons of other materials previously used, and such carbons so previously used?

A. I do not remember.

1477 x-Q. What machine were you using at this time? 2777

A. That I don't remember.

1478 x-Q. Did you know at that time, other things being equal, that the incandescence of the carbon would depend upon the resistance of the carbon and the quantity of current conveyed to it?

A. No, I don't think that is an accurate statement; but as the quantity of current was interdependent with the electro-motor force and the resistance in the 2778 circuit and also that the work done in the lamp with a given current was dependent upon its resistance, relatively to other resistances in the circuit, it does not seem to me that your statement, to which you wish me to assent, is accurate. We knew that the current remaining the same, the incandescence of the lamp would be increased as its resistance was increased, relatively to the total resistance in the circuit; in other words, that the work would be done where the resistance existed. 2779

1479 x-Q. You say that you do not remember the machine that you were using at this time, can you give me any idea of its electro-motive force, or the quantity of current generated by it?

A. No, only that it was sufficient to light up our lamps.

1480 x-Q. Would it light up equally well any and all carbons, irrespective of their size or character?

A. No.

1481 x-Q. Which would it light up the best? 2780

A. Those that we adapted in size and resistance to the current produced.

1482 x-Q. What was the size and resistance best adapted to this current?

A. That I don't know.

1483 x-Q. Can you not give me any idea?

A. I have already given that in the size and shape of the carbons we used. I will add that it frequently

2781 happened that we could light up with our current as we adapted the carbon only one, two or three lamps at a time; some of the carbons were such that if we undertook to place a number of lamps in multiple arc, the quantity of current was not sufficient to light them all up; again, some of them were of so high resistance that the electro-motive force was not sufficient to pass the current through more than one, two or three of them, when placed in series. Of course the carbons
2782 were different at different times and in different lamps.

1484 x-Q. Now, with a given machine you could only produce given results. You don't remember the machine you had this time, and you can tell me neither its volts nor ampere capacity; if you are intelligently conducting your experiments you must have made your lamps with some reference to your machine, and arranged them, if several were used, with reference to it. If the resistance of your carbon was a hundred ohms and the electro-motive of your machine ten volts, the
2783 carbon would not become incandescent. On the other hand, if the resistance of the carbon was a fraction of an ohm, and the electric force of the machine two hundred volts, and no resistance in the circuit, the carbon would be destroyed. Again, the durability of the carbon and of the whole lamp of necessity depends upon the relation the lamp bears to the current which is conveyed to it. Can you not tell me, therefore, what work this machine would do in the way of running carbons to incandescence?

2784 A. You forget, in criticizing our work, which is all the point I see in the question, that the appliances of that day were not those of to-day. You leave out of consideration the fact that we had not then perfected a system of incandescent lighting and were working to that end. I have no other answer to make to your question, other than that we did such work as was necessary to run the carbons in the lamp to incandes-

cence, and ascertain what we wanted to know, which was to know if such carbons could be used. I cannot give electro-motive force, ampere resistance nor volts with any degree of accuracy, and can only say that they varied at different times. 2785

1485 x-Q. I take it you must have known what this machine would do, and what it would not do, and that fact I am anxious to as certain; now, if it was of such capacity as to run a lamp of a fraction of an ohm's resistance to incandescence, a lamp of a hundred ohms resistance would not be adapted to this machine; again, 2786
if several lamps of the same resistance were and arranged in series, and could be run to incandescence, these lamps could not be placed in multiple arc, without a different result. Can you not tell me, therefore, what this machine would do and how you adapted your lamp to it?

> Question objected to upon the ground that it is mere repetition, the witness having already stated repeatedly that he does not recollect 2787
> or know the volts or amperes of the machine, and that they had simply a machine or machines to which they adapted their lamps in their resistance, to enable them to determine the practicability of an incandescent conductor made of carbonized paper of an electric lamp.

> Question is further objected to on the ground that it is false in its inferences, in that it assumes that the experiments were not in- 2788
> telligent.

A. I answer, I do not know now, if I ever did know, the capacity of the machines we used. I agree with you that we did not do impossible things. We did do what I have said we did.

1486 x-Q. Would this machine light up lamps

2789 equally well, of low or high resistance, and whether arranged in series or multiple arc?

Question objected to, on the ground that there is no issue of high or low resistance in this case, nor is there any question as to whether the lamps are in series or in multiple arc. If, as a matter of fact, the dynamo was sufficient to prove that a good practical incandesent conductor could be made from car-
2790 bonized paper, it is sufficient upon the issues of this case. Question being wholly immaterial for the reason stated.

A. All I can say in regard to that is, that we did light up lamps with the machines we used and our other appliances both in series and in multiple arc as well.

1487 x-Q. I am speaking of the machine you had when you first tried to run the paper carbons to incandescence. Was that machine equally adapted to
2791 run to incandescence high and low resistance lamps whether in series or multiple arc?

A. I do not remember the machine we had in use with these first experiments of paper carbons. If you wish to say that a machine must be adapted and run to the work required of it, or the work required of it adapted to the machine, I agree with you.

1488 x-Q. I am desirous of getting the facts with regard to these experiments. If you used one machine you must have found that with different arrangements
2792 of lamps and different resistances of conductors, different results would follow; this is true, is it not?

A. Yes; and different results would follow, according to the velocity at which the machine was run, the manner of excitation of its field magnet, the extent of that excitation, and the differing resistances in the circuit.

1489 x-Q. Very well. Could you have used a ma-

chine for any time without ascertaining what results it would produce? 2793

A. We probably did know at the time the limits in work of the machines used at the time, and their capacity for different kinds of work, that is, work done by greater or less electro-motive force.

1490 x-Q. You must have known these things if you were working intelligently, must you not?

A. Within certain limits, I think so.

1491 x-Q. Now, if a machine were adapted to run to 2794
incandescence a conductor of one ohm's resistance, there being no other resistance in the circuit, you could not take that lamp out of circuit and put in a lamp of a hundred ohms and run it to incandescence, leaving everything else unchanged, could you?

A. Not without changing the velocity of the machine or increasing its electro-motive force in some way.

1492 x-Q. Then, with a given machine, if you experiment with lamps having carbons of different re-
resistance, you must have known what effect the ma- 2795
chine would produce, would you not?

A. Within the limits of variability of the machine we must have known either in electric units of measurement, or in practical manifestation of work.

1493 x-Q. Now you don't remember electrical units, do you remember manifestation of work as to the machine you had when you first tried these paper carbons?

A. Only to the extent I have stated, in the general fact that it heated up the carbons to incandescence; 2796
how many, whether one or more, and when more, how arranged, or what resistances were in circuit, I cannot remember.

1494 x-Q. Do you appreciate that, if I could ascertain, either in electrical units, the capacity of this machine, or by a clear statement from you of the work that it would do under given conditions, I would be

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able then to demonstrate just what could or could not be done by this machine; or, in other words, I would be in a position to verify or demonstrate the incorrectness of your statement.

A. I would be glad to give you every detail, if it were in my power to do so, knowing that it would demonstrate the truth of my statements. Had I then appreciated as fully as I now do the value of what we were doing, and the consequent value of perfect, com-
2798 plete and accurate record of every experiment, I should not be placed in the position of not being able to give details; further than this, it is proper to say that such peculiar, unusual and persistent efforts as have been made in this case to overthrow, deny and belittle the work done by us was not anticipated by myself or my co-worker.

1495 x-Q. Do you intend to answer yes to my previous question?

A. No, I do not think it would make any change what-
2799 ever in this matter, or that you would be able, or rather willing, to admit the demonstration, if adverse to your preconceived ideas or those of your clients. I admit that if all the details, complete, of our work, were in the hands of parties unbiased and impartial, and sufficiently intelligent, it would enable them to demonstrate the truth of what I have stated.

1496 x-Q. It seems to me that while you testify very positively as to what results you accomplished, your memory is remarkably defective as to the means by which they were accomplished. You were one of
2800 the inventors, your co-inventor is dead; if I could ascertain from you the facts upon which the general results as to which you testify depend, I would either greatly strengthen your case, or be in a position to show that the general results of which you speak could not have been accomplished with the means at your command. Now I have interrogated you as to a necessary factor in the experiments you performed on

2801

carbons, to wit: The dynamo machine used by you in running the first paper carbon to incandescence; if, with this machine, you tried to run to incandescent carbons varying in size and in resistance, due to this variance, or varying in resistance by reason of different size and difference in the character of the carbon, and if of these carbons, or any of them, more than one was placed in circuit, or their arrangement varied, it would seem to me incomprehensible that you could not give
me some idea of the work this machine would do. Do 2802
you wish to occupy this position before the Court, that you remember distinctly making lamps containing carbons of different sizes and of different character, and running them to incandescence by this machine: that they were arranged in series and multiple arc; that few or many lamps were placed in circuit; that under all conditions the current was adapted to the lamps; but that you have absolutely no recollection as to what condition of resistance or arrangement the
machine was best adapted to? 2803

A. No, I do not want to occupy any position before the Court hypothetically suggested by you in your question, containing, as it does, statements, omissions, and inferences not warranted by anything I have said. I wish to occupy before the Court just that position which is shown by my testimony and no other. It is not strange that I cannot remember details, and that results best remain in my mind.

Adjourned till November 11, at 1 P. M. 2804

2805 NEW YORK, Nov. 11th, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows:

Witness here desires to add to his last answer the following:

2806 There is another reason, perhaps, why I do not remember more in regard to electrical details, units and capacities. Mr. Sawyer took principal charge of the running of the dynamos, their arrangement, the arrangement of the lamps, the switches, shunts and resistances, and he made the electrical measurements that were made. If he were alive, he might be able to give the details, which I, knowing them probably at the time, but not personally working them out, cannot remember.

2807 1497 x-Q. I have tried to get from you the capacity of the dynamo machine, in order that I may identify the machine you used as closely as possible, having interrogated you previously, as to the various machines you used at different times. Please tell me, as near as you can recollect, when paper carbons were first run to incandescence?

A. I have already answered that question, that I did not know; but the nearest approximation I could give, was about two or three weeks after we went to 43 Centre street. It might have been earlier or later.

2808 1498 x-Q. Have you any recollection or impression as to which dynamo machine you were then using?

A. I have not.

1499 x-Q. Does nothing in the experiments enable you to remember?

A. No, I don't remember anything now.

1500 x-Q. You had tried to run to incandescence

before trying these paper carbons, carbons varying in 2809
size and resistance, had you not?

A. Yes.

1501 x-Q. Had you found in trying such carbons, so varying, that with the same current, different results would be produced upon the different carbons?

A. We did not need to try it to know that.

1502 x-Q. I am anxious to know the fact, so please tell me what you found in practice?

A. That some carbons were of too high a resistance 2810
and some carbons of too low a resistance, according to their arrangement, and the current attempted to be used upon them at the time, to be properly lighted up. In explanation of this answer I will add: The currents from the same machines were very variable at different times, on different days and on the same day, due to our want of control of the motive power, and to the variable work going on in the factory, of which ours constituted a very small part.

1503 x-Q. You say that some carbons were of too 2811
high a resistance and some of too low a resistance, according to their arrangement and the current attempted to be used upon them. Can you give me no idea whatever as to what carbons were too high and what too low, and what the arrangement was to which you refer—I am speaking of the time you first tried these paper carbons and of the prior period?

A. The same carbons when arranged in series would be or constitute too high a resistance at one time,
for us to get a current through them to heat them 2812
up—illuminate them; placed in a multiple arc or multiple arc series, they would perhaps be lighted up. Again, when placed in multiple arc, the same number of carbons would make too small a resistance and not be properly illuminated, due to the variance of the current, when a less number of carbons placed in series would be. Now, to distinguish at this time what car-

2813 bons were used would be impossible for me. Again, we attempted to use single carbons in a single lamp, which alone constituted too high a resistance for us to get sufficient current through them to heat them up, at one time; when at another time the same carbons would be beautifully lighted up. At another time a single carbon of too large size would not be lighted up by the machine, being too small in resistance, or the current being too small. At another time the carbon would be lighted up. I cannot at this time distinguish
2814 what particular carbons these were. Again, we used different qualities of carbon for the conductors, some of higher resistance than we could ordinarily light up, but we sometimes *could* light up. If you will specify any particular carbon, and will call my attention to it, and have any recollection of it, I will try to answer more fully.

1504 x-Q. Were you then so ignorant of the capacity of the machine while conducting these experiments, that you could form no idea beforehand when putting
2815 a lamp in circuit, what the effect would be, and were dependent upon the trial to ascertain?

A. I have already explained the cause of this variance, in the varying force we were using. Could we know the velocity beforehand at which our machine would run or continue to run? I think we knew enough at the time of the capacity of the different machines we used to adjust the lamps to the current that would be produced, but it is true that I myself personally, at the time, knew very little about dynamo ma-
2816 chines. Mr. Sawyer was very much better informed than I was in regard to the matter. We were, I think, at this time, as every one else was, dependent upon the trial of machines to ascertain their capacity.

1505 x-Q. You don't answer my question. I am speaking of a time which your best recollection fixes as two or three weeks after you went to Centre St., and

I want to know if you were so ignorant of the capacity of the machines you used, as to be able to form no idea as to the effect it would have on a given carbon when placed in circuit, and were dependent upon actual experiment to ascertain? 2817

A. To this I answer, no. We could and did form an idea of the matter and usually correct ideas, as demonstrated by trial, but we made a great many mistakes.

1506 x-Q. That being so, do you now remember what your use had taught you as to the capacity of the machine? 2818

A. No, not to relate the whole or any considerable portion of what we had learned.

1507 x-Q. I would be satisfied with the very slight idea; so if you can tell me anything in regard to the capacity of the machine I should like it?

A. I cannot undertake to state at this length of time and confining it to that period, or to any particular machine.

1508 x-Q. Could you have ascertained anything of value regarding the value of any carbons used in your 2819
experiments with a machine which would at different times produce entirely different results?

A. Yes, I think so. No machine was necessary to learn very much about the qualities of carbons.

1509 x-Q. The effect produced on the carbons is dependent upon the quantity and character of the current conveyed to it. That is true, is it not?

A. Yes.

1510 x-Q. A carbon of too high resistance for the electro-motive force of the machines would not be 2820
heated up?

A. No.

1511 x-Q. A carbon of too low a resistance for the electro-motive force would be so brilliantly lighted up as to be destroyed, would it not?

A. Not necessarily. A carbon of too low a resis-

2821 tance for the quantity of current furnished, would not be heated up.

1512 x-Q. Assuming no other resistance than the lamp in circuit, the carbon if of low resistance and the current of high electro-motive force, the carbon would be so brilliantly lighted up that it would be destroyed, would it not?

A. Assuming the power used to be sufficient, yes.

1513 x-Q. You, therefore, have to have a carbon,
2822 which in its resistance has relation to the current conveyed to it, for the intelligent conduct of any experiments looking toward ascertaining the quality of the carbon, have you not, as an incandescent conductor?

A. No, experiments outside of the use of any dynamo current might be intelligently conducted for determining the quality, character and resistance of a carbon and its suitability for an incandescent conductor for a lamp and without knowing the exact relations of the current used to the resistance of the carbon; intelli-
2823 gent experiment might be conducted with the use of a current by observation of the effect upon the carbon of certain temperatures higher or less high.

1514 x-Q. If you only had a current of five volts electro-motive force could you conduct experiments on lamps having conductors of a hundred ohms resistance?

A. No, you would have to have sufficient electro-motive force to pass sufficient current through the incandescent conductor to heat it up.

2824 1515 x-Q. If you had a current of a hundred volts electro-motive force and lamps of a fraction of an ohm's resistance, could you conduct experiments with but one such lamp in circuit, no other resistance outside the machine being in circuit but the lamp?

A. No, not practically. You would probably burn up the machine or burst up your lamp, if the power

were sufficient. Of course, the experiment could be tried and so much would be learned from it. 2825

1516 x-Q. A person then while using the same machine, but trying carbons of varying size and resistance would of necessity learn, if not in electrical units, in effects produced, the capacity of that machine, would he not?

A. If he did not destroy his machine or his lamp he might get some idea of it, and probably would.

1517 x-Q. From a given machine in a given condition 2826
with an armature revolving at a given speed, and with a circuit of definite resistance, a current of definite quantity and electro-motive force results?

A. Yes.

Adjourned till Friday, the 18th inst., at 10 A M.

FRIDAY, Nov. 25th, 1887. 2827

Met pursuant to agreement of counsel.

Present:—Counsel as before, and the cross-examination of Mr. Man was continued as follows:

1518 x-Q. When trying these first experiments on paper carbons did you burn up your dynamo machine?

A. Whether with these carbons or others I cannot recollect, we did destroy the insulation of the dynamo machine or injure it so that it had to be rewound or repaired. 2828

1519 x-Q. What insulation do you refer to?

A. The insulation of the wires with which it was wound, I suppose the armature. I did not look to it personally, and I think it occurred several times.

1520 x-Q. To what did you attribute, at the time, this injury to the machine?

2829

A. Substantially short circuiting it; too little resistance outside of the machine.

Complainant's counsel instructs the witness to state, in case he had nothing personally to do with the management and manipulation of the dynamo in the experiments about which he is testifying, to say so upon the record, in answer to any future question of counsel the object of counsel being to ascertain
2830 whether the witness has or had personal knowledge of the manipulation and management of the dynamo, or whether he is testifying to his recollection merely of what Mr. Sawyer told him about it.

Defendant's counsel objects to the instruction above given as improper.

1521 x-Q. Can you remember which machine it was that was injured in this way?

2831 A. I think it was more than one, perhaps more than two or three, but I cannot remember to distinguish: I did not have personal charge of the running of the dynamos, but Mr. Sawyer had and usually run them, and had charge of the running and manipulation of the dynamos and circuits.

1522 x-Q. Was the arc light machine one of these that was burned out?

A. I have no recollection in regard to that machine being burned out?

2832 1523 x-Q. Your best recollection is that it was some of the machines that you had in your room?

A. That is my impression.

1524 x-Q. From the time you ceased using the arc light machine in the basement and until you got the specially wound machine, I understand the machines you used were those you borrowed from Arnoux and

Hochausen; was it these machines, thus borrowed, that you burned out? 2833

A. We had, while we were at 43 Centre street, whether at this time or later I can't recollect, other machines, among which was one or more of Westons; I should think, however, that the machines that were injured were those of Arnoux and Hochausen; my best recollection would be that one or more of them was a borrowed machine, and that also the one we bought of them was injured.

1525 x-Q. Do you remember whether the first machine you had in your room at Centre street was burned out in this way? 2834

A. No; I remember only that it was out of order, or got so.

1526 x-Q. So that it could no longer be used?

A. No; I think we did make some use of it, but it was ineffective or crippled or diminished in efficiency.

1527 x-Q. Was it so inefficient that you had to get another machine?

A. We did get another machine, I don't know whether for this cause—possibly it was, but I do not recollect. 2835

1528 x-Q. Was the second machine of the same make and general capacity as the first?

A. It was of the same general type, whether of exactly the same make I don't know, nor do I know its capacity.

1529 x-Q. After you got the specially wound machine, was it, or any of the machines you had at Centre street, after its delivery, burned out? 2836

A. I have already answered that question as far as I can. I repeat: My impression is that both it and other machines were injured and had to be repaired.

1530 x-Q. Do you remember whether your getting different machines was caused solely by the destruction of the machines you had been using, or was prompted by other reasons?

2837

A. I think it was prompted also by other reasons.

1531 x-Q. Do you know?

A. I believe it was, and am confident as far as one could be at such a length of time, that such was the fact—I think we were trying different machines as to their capacity and suitability for our use.

1532 x-Q. But do you not now remember what capacity you desired, or in what "suitability for your use" consisted?

A. I do not, as these matters were in charge of Mr.
2838 Sawyer, and he ran the machines and tested them; I doubtless knew at the time, but do not recollect.

1533 x-Q. You say in answer to question 1516 that a person while using the same machine, but trying carbons of varying size and resistance, if he did not destroy his machine or his lamp, might, and probably would, get some idea of the capacity of his machine. This being so, have you no recollection of the capacity of the machine you used when first trying these paper carbons?

2839 A. I have no recollection of the electrical units, if I knew them. In effects we succeed in passing current through paper carbons and heating them up to incandescence. Some paper carbons that we tried were of so high resistance that we could not get a current through in sufficient quantity to heat them up; in others we did. I am speaking of the first batch of paper carbons.

1534 x-Q. Do you remember whether the machine which applied the current to this first batch was in
2840 your room or not?

A. I have stated already that I do not.

1535 x-Q. You do not remember the machine you used in heating up these first carbons; do you remember whether you ever afterwards regarded it as unsuited to carbons made from paper or fibrous material?

A. Not recollecting the machine I could not do so

2841

one way or the other. I remember subsequently, and after we cut the carbons to shape before carbonization, having difficulty in getting a current through the carbons in the first instance with the current at our disposal, and I remember rapidly making and breaking connection between the poles of the machine with a file, and with a saw, and with a notched piece of iron, to force the current through these carbons in the first instance.

1536 x-Q. Do you remember whether the machine to 2842
which you last refer was the same machine as you used in your experiments on the first paper carbons?

A. I do not.

1537 x-Q. I understand you to remember distinctly two things concerning the trial of these first paper carbons: First, that through some you did not get current in sufficient quantity to heat them up; that others you could heat up—am I right?

A. Yes.

1538 x-Q. Do you remember whether, in the case 2843
where the paper carbon did not become incandescent there was any other resistance in circuit outside the machine than the single lamp containing the carbon?

A. I only remember that we had adjustable resistances in the circuits as we ordinarily used our lamps and experimented. These resistances could be diminished to little or nothing or increased to a great many ohms. I cannot recollect the arrangement in our experiments with the first paper carbons. I assume, 2844
however, that we had little or no resistance except a single carbon in circuit when the current was first passed through the paper carbons.

1539 x-Q. In those cases where the paper carbon was heated up was there any resistance in the circuit other than the paper carbon?

A. I repeat my last answer. Probably not at first.

1540 x-Q. We then have this fact, as I understand,

2845 that whatever machine you used at this time its capacity was not sufficient to run to incandescence some of these paper carbons, or in other words, some of these paper carbons were of too high a resistance for this machine?

A. No, that is not necessarily so; because it assumes that we tried only one machine upon these paper carbons. If we tried more it would be true when the current was not passed through the carbon
2846 that the machine then used in that experiment did not have sufficient electro-motive force to pass sufficient current through that carbon to heat it up to incandescence.

1541 x-Q. I speak of the machine you used in running the first batch of carbons to incandescence; I have understood you to say that that machine would run some of the carbons to incandescence, but not others. Have I understood you?

A. You have. I have simply stated that with some
2847 of the paper carbons first made we succeeded in heating them up to incandescence with the current we were using at the time without reference to dynamo machines, for I do not recollect them, and that at other times, with some of those paper carbons we did not get sufficient current through them to heat them up. I have not stated, and do not intend to state and do not know whether we used more than one dynamo machine with these carbons. Furthermore I have stated that with the same machines we got at different times
2848 different electro-motive force, for reasons which I have fully explained. Nevertheless it is true, and that is the impression I wish to convey, that some of these paper carbons we thought were of too high resistance for practical use with the current we had.

1542 x-Q. Well, which were these paper carbons?

A. They were the smallest and longest ones; those of highest resistance.

1543 x-Q. Please tell me as near as you can the length and cross section of the carbons to which you refer? 2849

A. I have already given them as near as I can recollect. Do you mean those of highest resistance?

1544 x-Q. I mean those which you "thought were of too high resistance with the current that we (you) had?"

A. They were less than a thirty-second of an inch in diameter in one direction, of the thickness of carbonized blotting paper, of a cross section at right angles to this, approximating one-sixteenth of an inch, perhaps less than that, and of a length of an inch or more. These dimensions cannot be accurate, and I speak from examination of a guage and these carbons, in my mind's eye, after nearly eight years; I give you simply my judgment of the matter at the present time. 2850

1545 x-Q. Did you ever do any further carbonizing at your house than the single instance you have mentioned? 2851

A. Yes.

1546 x-Q. How long after this time was it?

A. Right away, within a day or two.

1547 x-Q. Did you use the same iron box as previously?

A. Yes, and others.

1548 x-Q. Do you mean you used two boxes in the second carbonization?

A. I cannot tell whether I used two boxes in the second carbonization or in subsequent carbonizations; I used more than one in the fire at the same time, and made a good many carbonizations within a week or ten days. 2852

1549 x-Q. What did you carbonize in the second carbonization?

A. After the first carbonization we cut paper of different thicknesses, some of them cemented together, into shapes for incandescent conductors, of different shapes

2853

and sizes and lengths, and I think we cut slips of wood—my impression is, first, of willow into shapes, sizes and lengths for incandescent conductors, and I think, in the second carbonization, the box or boxes contained the wood and paper in the same box.

1550 x-Q. Had the paper or wood been treated in any way?

A. No further than where the paper was cemented together, to give it greater thickness; some carbona-
2854 ceous material was used as a cement, and that the paper was pressed and consolidated.

1551 x-Q. Do I understand that in this second carbonization, which was done at your house, the material to be carbonized was cut to the desired shape and size of the conductor?

A. Yes, to the desired shape and size to make a conductor.

1552 x-Q. Did you then prefer any special shape or size, or any general shape or size?

A. We preferred a shape that, when the conductor
2855 was placed in the holders it would rise above them, but, as to size, we made the blanks of various sizes and various lengths for trial, and we did not make them all of the curved form to rise above the holders, but many were straight; our opinion perhaps was tentative as to what would prove best at this time.

1553 x-Q. What kinds of paper did you carbonize at this second trial.

A. Only white blotting paper: it may have been that some card or drawing paper was used at this second
2856 trial.

1554 x-Q Do you remember what your reason was for using only blotting paper at this second carbonization?

A. Yes; we thought that the white blotting paper, not having been treated in its manufacture with any other substances, and being pure cellulose, would make a purer carbon.

2857

1555 x-Q. Describe the willow you carbonized this second time, what kind of willow it was, and how it was cut, and what your object was in carbonizing it?

A. The willow was ordinary willow, such as used by basket-makers; was cut out in straight pencils; the object was to make an incandescent burner of willow charcoal.

1556 x-Q. Had you any theory on the subject of what the qualities of such substance would be?

A. I had an idea that willow charcoal was most free from impurities; that was the reason for my selecting 2858
willow.

1557 x-Q. Your recollection is, as I understand, that this second carbonization was within a day or two after the first; did you carbonize again at your house, and, if so, how soon was the next carbonization?

A. I followed up these carbonizations with a good many more at my house; I think they were all done at my house, but some may possibly have been done in the furnace at 43 Centre street.

1558 x-Q. You don't tell me how soon the third car- 2859
bonization was after the second?

A. I don't recollect.

1559 x-Q. Well, about how long?

A. In my second carbonization, or in one of those made very soon after the first, I burned up one of the boxes and spoiled the carbons, and I very soon spoiled the first box that I used; I should think the third carbonization, from recollection, was within a week or ten days of the first.

1560 x-Q. What did you carbonize the third time? 2860

A. I should think only white blotting paper and willow wood, but I cannot undertake to remember the minute details of this work.

1561 x-Q. Was the material carbonized treated in any way?

A. No, except where cemented together and pressed.

2861 1562 x-Q. Was the material cut to the desired shape and size of the conductor before carbonization?

A. Yes.

1563 x-Q. Had you at this third carbonization determined on any general size or shape?

A. I don't think further than I have before stated.

1564 x-Q. On how many separate occasions did you carbonize at your house while the laboratory was at 43 Centre street?

2862 A. I cannot recollect; a good many; I burned up several boxes, I got some wrought iron boxes and covered them with clay and finally used crucibles, luting their covers down with clay and making a small vent for the escape of gases?

1565 x-Q. What would be your best recollection as to the number of times you carbonized at your house?

A. I won't undertake to state; I should think twenty-five or thirty times and probably more, but I cannot undertake to recollect at this length of time.

2863 1566 x-Q. Was it your habit to pack the boxes at 43 Centre street, take them to your house, carbonize them and then take them back to Centre street?

A. With the metal boxes I think that was done, but not altogether with the crucibles.

1567 x-Q. What material, if any, other than paper and willow wood did you carbonize at your house?

A. I carbonized a variety of woods, every kind that I could get hold of; I also carbonized strings of different kinds and different materials; I think, broom
2864 corn; woods cut into strips and bent; different shapes of paper; some woods in the form of veneers worked down extremely thin and cemented together with the fibres running in different directions; excelsior, I think; manilla; I don't now recollect all the things that I carbonized; I also re-carbonized after this different things after saturating them with pure white sugar after the first carbonization.

1568 x-Q. What object had you in view in carbonizing these different substances? 2865

A. We wanted to get pure carbon that would be sufficiently elastic and strong and not liable to break, and that would endure the strain put upon the incandescent conductor of an electric lamp. Perhaps it would be summed up in calling it a structural carbon, that is, one in which the material to be carbonized had been formed by nature, and in which the natural form was being preserved after carbonization, we thought some 2866
advantages might be derived. To give an illustration of the subject matter of our thoughts, we had procured and we made carbons for the incandescent conductor of an electric lamp made of pulverulent materials in which, when pressed into form, the arrangement was heterogeneous. These carbons we found, or thought we did, were liable to fracture and disintegration by the current, and we were trying to get a carbon that would stand "the racket," as Sawyer said. A further illustration: The mineral carbons and 2867
other made-up carbons were so far rigid that by the least flexture or bending they were broken, while the vegetable carbons and those made especially of paper could be bent to a considerable extent, without breaking, showing their greater flexibility and elasticity; the mineral carbons and those made-up carbons were amorphous in their structure, while the others were fibrous.

1569 x-Q. You say you carbonized all these substances at your house in your cooking range in the 2868
hope of getting a pure carbon which would be elastic and strong, and not liable to break; of the different materials you carbonized did you regard them all as equally good?

A. No.

1570 x-Q. Did you try them all in your lamps?

A. I think that we tried all that I have mentioned, more or less.

2869

1571 x-Q. Did you try all the different shapes and sizes?

A. No, I don't think so; of the different materials, I think, on reflection, that we did not try, in the lamps the carbons made from wood veneers; I think they showed themselves defective without trying; I do not know that while at 43 Centre street, we tried the manilla fibres, pure and simple; my impression is that they were too fine, and I cannot be certain that we
2870 tried all the carbons made from different kinds of wood in the lamps, but most of them we did.

172 x-Q. Which of these various materials did you consider you got the best of carbon from?

A. They were three kinds at this time; my recollection is indistinct in regard to one of them, whether the trial of this one was preferably satisfactory to us when at 43 Centre street, or afterwards in the fall of 1878; the three from which we met the greatest success and which were preferred by us, in the
2871 order of preference at the time, were willow wood carbons, paper carbons, and carbons from broom corn, if our preference was established for that while at 43 Centre street, of which I am in doubt.

1573 x-Q. Now, of paper carbons, which paper did you consider made the best carbons?

A. White blotting paper we had the most success with.

1574 x-Q. Did you ever treat the material in any way before carbonization?

2872 A. Yes, we soaked the paper sometimes in sugar solution and we always compressed it. I think we also soaked different woods in sugar. I am not confident in regard to it, but I think we also impregnated the materials with different carbonaceous substances, such as oils, glues, etc., to reduce the resistance of the carbons after they were carbonized. This was not done till after the first few carbonizations at my house.

2873

1575 x-Q. You say you treated the materials before carbonization to reduce their resistance. Had you found the carbons of too high resistance?

A. We so treated some of them, and we had found that some of our carbons were of too high a resistance for our currents, and we also treated some of them in this manner for another purpose, that is, to make them more rigid; that is where they were to be used as straight pencils.

1576 x-Q. And you found that straight pencils of 2874
fibrous material were not sufficiently rigid for conductors?

A. That is perhaps too broad a statement. They were not sufficiently rigid to use in some of our lamps.

1577 x-Q. Were the only materials that were thus treated before carbonization these which would be of too high a resistance, or straight pencils whose rigidity you desired to increase?

A. No, I should think not. At first we crushed the ends of some of the paper carbons between the clamps 2875
in which they were held. To make the carbons harder and less easily crushed we soaked them in sugar, some of them before carbonization.

1578 x-Q. Did you ever adopt this treatment before carbonization as a general practice?

A. No, I don't think we did.

1579 x-Q. Did you consider it an advantageous thing to do?

A. Not more so than the treatment after carbonization. 2876

1580 x-Q. Question repeated.

A. For the purpose that we sought to attain, that I have mentioned, it was advantageous.

Adjourned till Monday, the 28th inst., at 10½ A. M.

2877

Monday, Nov. 28, 1887.

Adjourned till Tuesday the 29th inst., at request of defendant's counsel.

Tuesday, 29th Nov., 1887.

Met pursuant to adjournment.

Present—Counsel as before and the cross-examination of Mr. Man was continued as follows:

2878

1581 x-Q. I understand that where you wished to reduce the resistance, you treated material to be carbonized in the manner described, and also where you desired to use the materials as straight carbons, and you desired greater rigidity it was so treated; what other material was treated in this way?

A. Your statement needs correction. I simply said that we sometimes did this for the purpose stated; not that we did it always when we wanted to attain
2879 those ends, as your statement implies. I do not recollect what other substances we treated in this way; we frequently did it, but I cannot bear in mind what particular substances were used, further than I have stated.

1582 x-Q. Is it, then, the fact that you sometimes treated the material before carbonization, and at other times did not?

A. Yes, and I will add, to save further question, that we sometimes treated them in a similar manner after carbonization, and re-carbonized after treatment, and
2880 sometimes did not.

1583 x-Q. What I want to get at is, in what cases and for what reason you treated before carbonization, and in what cases and for what reason you did not trear before carbonization?

A. No further than I have already stated.

1584 x-Q. Did you ever form an opinion as to whether it was a good thing to do?

A. We formed an opinion that it accomplished the results we desired in practicing it—of making the carbon more dense, harder, and of less resistance, and that it was a good thing to do when we wanted to accomplish these things. 2881

1585 x-Q. Question repeated.

A. I have no further answer to it; I don't think we had any further opinion in regard to it than I have stated.

1586 x-Q. You never adopted this as a practice, I understand? 2882

A. We certainly did practice it, if that is what you mean?

1587 x-Q. You had not at this time, as I understand you, decided upon any desirable resistance for a conductor of any given shape and size?

A. No, I do not think we had, except in connection with the particular system and other things with which it was to be used.

1588 x-Q. Do I understand that you had decided this question with reference to the system that was to 2883
be used?

A. Most assuredly we had decided that the resistance must be a practical one for the current available, but I do not think we had decided in regard to the electro-motive force as a usual thing, which would be most suitable in a general system for use of incandescent lighting, and upon that, as a general proposition, would depend the resistance of the conductors to be used, taken in connection with the arrangement of the lamps. 2884

1589 x-Q. Had you determined anything more then, than that the resistance of the lamp must have relation to the current conveyed to the lamp?

A. In regard to what do you ask the question? Specify: do you mean in regard to the resistance of the conductor alone?

1590 x-Q. Question repeated.

2885

A. I don't know what you mean by "more"; what do you mean by "more" in regard to what?

1591 x-Q. I am trying to ascertain the object and extent of your treatment of paper or fibrous material before carbonization, and what, if any, decision you had come to in regard to the advisability of doing so; you say in some cases you did treat them, in others you did not; you practiced it, but did not adopt it as a practice; that it had the effect of reducing the resistance
2886 of the material, but that you had not determined upon any desirable resistance for a conductor of given shape or size; if I understand your answers, it would seem that you have no opinion whatever on the subject of its value, but that you only used it as an expedient in certain cases; is this correct?

A. If you will consent to take my testimony in the words in which I give it, instead of going on to state what I say, in your own fashion, and coupling great numbers of things together without accurately stat-
2887 ing what I say, and ask me whether it is correct or not, we will get along better and faster; you state that you are trying to ascertain, first, the object of the treatment of paper or fibrous material before carbonization; second, the extent of that treatment; third, what, if any, decision we had come to in regard to the advisability of doing so; I have fully answered in regard to the first and third things you say you are trying to ascertain; if you now ask me in regard to the extent of our practicing that thing as a fact, I can an-
2888 swer it; if I answer the question you put to me, I shall have to go back and correct your statement of my testimony.

Answer objected to as irresponsive.

1592 x-Q. Was this treatment before carbonization used only as an expedient in those cases where you desired to make the resistance of the conductor less than it would be if the material were not treated?

2889

A. No; it was used also for another purpose.

1593 x-Q. What other?

A. To make the carbon more dense and harder and better able to endure the clamps of the holders and other manipulation of the conductor.

1594 x-Q. Any other object?

A. I do not remember any other now.

1595 x-Q. Would you, then, in those cases where you desired to obtain these objects, treat the material, and in other cases not treat it? 2890

A. Yes.

1596 x-Q. Did you ever reach any conclusion as to whether it was desirable to, in some way, increase the density and hardness, and decrease the resistance of a carbon made from paper or fibrous material from what it would be if the material were simply carbonized and used without any treatment?

A. Not as an abstract question in and of and by itself; we did not reach a positive conclusion or opinion that our electrical treatment of carbons, which did 2891
reduce resistance, and increase the density and hardness, and decrease the resistance of a carbon made from paper was desirable, and we also had an opinion that it was a convenient way and useful in making certain carbons, to treat them before or after carbonization in carbonaceous solutions or liquids, and this did reduce resistance, and increase hardness and density.

1597 x-Q. To what extent did you treat material to be carbonized before carbonization, in your experiments?

A. I cannot at this length of time remember with 2892
accuracy, to state the extent of the treatment before carbonization, as distinguished from the treatment after carbonization. We sometimes did one and sometimes the other, and sometimes both. (I am referring to the time at 43 Centre street to which I understood you to refer), and taken together, we treated, I think, more considerably than we left untreated. I think a large

2893 majority of our carbons were so treated; almost all, I should think, while at 43 Centre street, but not all.

1598 x-Q. Almost all then, were treated either before or after carbonization?

A. I think so; either by the treatment of the sugar or carbonaceous solution, or by electrical treatment, in a hydro-carbon atmosphere, liquid or gaseous, both.

1599 x-Q. This latter was according to the process of the Sawyer and Man patent, to which we have referred?

2894 A. Yes, and we frequently treated the same carbons in both ways.

1600 x-Q. Who assisted in this treatment either before or after carbonization?

A. The electrical treatment was almost always done by Mr. Wm. E. Sawyer. The other treatment I frequently performed, and I think I frequently had the assistance of all three of the Sawyers, Mr. Wm. E. Sawyer superintending it when I was absent.

1601 x-Q. Were you usually present when the elec-
2895 trical treatment was done?

A. I was sometimes present and sometimes not. The bulk of the time I was not at Centre street and the work went on whether I was present or not.

1602 x-Q. Did anybody assist you in the carbonization at your house?

A. Yes; the servant usually assisted me, and once or twice I think Mr. Wm. E. Sawyer was over there. Sometimes I had no assistance.

1603 x-Q. Who was the servant to whom you refer?

2896 A. I really couldn't tell. She is not with me now; she simply built up the fire for me and handed me things, and so on.

1604 x-Q. You say you preferred, of the various materials you carbonized, first, willow carbon, and second, paper carbon. What were the qualities in willow car-

bon that made you prefer it to carbons made from other fibrous materials? 2897

A. I do not know anything except that we were more successful in the use of it in our lamps while at 43 Centre street, and could easily get it into the shapes and sizes we wanted.

1605 x-Q. What properties did you find in paper carbon that made you prefer it to other carbonized fibrous material, with the exception of willow?

A. We thought that the arrangement of the fibres in 2898
the paper carbon was an advantage, and we also thought that, it being already of the size or sizes, in one direction, which we desired, being in flat, thin sheets, or easily made or selected of the dimensions in one direction, which were required for the incandescent conductor, and easily put in shape or cut in shape for the conductor before carbonization, and both the willow and paper carbons being pure carbons, or substantially so, that these were most advantageous, and they proved the most successful of the carbons in use 2899
in our lamps. We also thought that their fibrous structure, retained after carbonization, was an advantage. We also found that these substances were best carbonized without fracture, except some fibres and strings of which we made little use at the time, except by way of experiment.

1606 x-Q. What was the arrangement of the fibres in the paper carbon to which you refer in your last answer as an advantage?

A. They were all laid in one plane. 2900

1607 x-Q. Is this true of all papers, or only of certain kinds?

A. It is generally true of all; not absolutely true of any, but approximately.

1608 x-Q. What was the advantage which you attributed to this arrangement of fibres?

A. That they, the fibres, were less easily broken in

2901 the direction of their length than in the direction of their cross section, more of the fibres of paper carbon would lie in the direction of the length of the incandescent conductor than would be the case in a substance not reduced to sheets, and therefore they would not be so easily broken or so fragile.

1609 x-Q. Aside from any case of cutting or shaping to the desired size, what were the properties possessed by carbon made from willow as a material which you

2902 considered advantageous?

A. Simply that the fibres run in the direction of the length of the conductor, and that it was a pure material, made a pure carbon, that is, aside from the convenience of getting it into shape.

1610 x-Q. Would not the fact whether the fibres of the material ran in the direction of the length of the conductor depend on how the willow was cut?

A. Yes; but we cut them to make them run in that direction; the same is true to some extent with paper;

2903 the fibres mainly run in one direction, and we cut them to avail ourselves of this fact.

1611 x-Q. You speak in your 1605th answer of an advantage due to the retention of the fibrous structure after carbonization. In what did the advantage referred to consist?

A. Strength and resistance to fracture in the direction of the length of the fibre, and possibly in the direction at right angles, or other directions, possibly also elasticity or flexibility, or both.

2904 1612 x-Q. How long had you been experimenting with paper or willow carbon before you concluded that they were preferable to other carbon?

A. I cannot tell; I know that when we left 43 Centre street we thought that they were preferable to all we had tried of fibrous carbons.

1613 x-Q. How long was it before you made up your mind that the fibrous was superior to the non-fibrous carbon?

2905

A. I don't know that as carbon I ever made up my mind to that effect.

1614 x-Q. As the carbon for an incandescent conductor?

A. I have already testified very fully in regard to this subject-matter, and I do not wish to be misunderstood in regard to it; I only stated, in substance, that the incandescent conductor made from fibrous or textile material, taking everything into account, including purity, practicability, cheapness and ease of manufac- 2906 ture, of proper size and length, was, on the whole, the best that I had known of.

1615 x-Q. Of the carbons tried in Centre street the great majority were not fibrous carbons?

A. I think not.

1616 x-Q. They were French carbons, were they not?

A. They were mineral carbons, so-called, and deposit carbons.

1617 x-Q. At the time of leaving Centre street had 2907 you any preference for fibrous carbons over non-fibrous carbons?

A. At the time of leaving Centre street I had an idea that in the end the fibrous carbons would prove the best to use for the incandescent conductor of an electric lamp, but my mind on that subject-matter I do not think was fully made up; that is, I had not demonstrated to my satisfaction that such was the fact.

1618 x-Q. What were Mr. Sawyer's views?

Objected to as incompetent. 2908

A. I do not think that at that time there was any difference of opinion between us about the subject-matter: perhaps I was strongest in my views about it.

1619 x-Q. Do you mean that Sawyer thought that fibrous material would prove the best?

Objected to as incompetent.

2909
A. I mean to say that I think Sawyer thought that our incandescent conductor made from fibrous material would prove a good conductor; whether he thought as I did, that it would or might prove the best, I cannot say.

Adjourned till Wednesday, the 30th inst., at 1 P. M.

2910 NEW YORK, Nov. 30, 1887.

Met pursuant to adjournment; and the cross-examination of MR. MAN continued as follows:

1620 x-Q. Referring to the treatment before carbonization, please to state what the general nature of the carbonaceous solution with which you soaked the paper was, what your method of thus treating it was what effect the treatment had, and what materials you thus treated. You have spoken also of pressing and consolidating the material before carbonization; will
2911 you please explain how this pressure was effected, and what the effect of such pressure was on the material thus pressed?

A. The material with which we usually treated the fibrous substances to be carbonized before carbonization was a solution of refined white sugar—we may have used, and I think we did, isinglass or glue and oils; whether the oils were at 43 Centre street I can't recollect; we soaked the fibrous substances in these solutions, dried them, resoaked them, until we thought
2912 we had got them fully saturated with the sugar or other carbonaceous material or sufficiently filled with it for the purpose we intended; the effect was to fill the pores of the substance more or less with the carbonaceous material as we desired; after thus filling the pores, and while the material was in a condition to do so, we pressed it between the smooth plates in a screw

2913
press or vice to consolidate it; we carefully afterwards dried it, sometimes in a muffle, to drive off the water, carrying the heat in the drying process as far as we could without charring the material; the substances we thus treated were paper and strings of different kinds, and wood, except that we did not press the wood, and we did not treat before carbonization with the carbonaceous solution, but a small part, comparatively very few; usually, when treated in this way at all, they were treated after the first carbonization, but we usually 2914
pressed or consolidated the fibrous materials, paper and other kinds, except woods, before carbonizing them, or hammered them for the same purpose on a smooth anvil with a strong hammer; I think also we stiffened some of the strings that we carbonized with starch instead of sugar, and the effect was to render the carbon formed from the material more dense, and for the same size of higher conductability, or less resistance; it was also harder and better suited for handling and manipulation without breakage, as we thought. 2915

1621 x-Q. In some instances, as I understand you, the material was re-soaked and recarbonized several times?

A. It was.

1622 x-Q. Now, as I understand, the material was treated after carbonization either by the electrical treatment solution or both, the electrical treatment being your patented treatment?

A. Yes.

1622 x-Q. When did you begin this electrical treatment with reference to your experiments on paper? 2916

A. With our first carbonizations of paper we put them in a bath of hydro-carbon gas or in a lamp containing hydro-carbon gas to try them; before then we had discovered the electro deposit of carbon upon an incandescent conductor heated up in an atmosphere of hydro-carbon gas, but I do not think that we put the first paper carbons into this atmosphere in the first

2917 instance with the intention to treat them, but because it was the most convenient way of trying the carbons, the atmosphere of the lamp or vessel in which they were tried being readily supplied, re-supplied and kept up from the gas pipes; we knew then that their resistance would be reduced rapidly by this treatment or use.

1624 x-Q. Am I correct in understanding that all the carbons, irrespective of the kind of fibrous or textile material from which they were made, were treated
2918 by this patented electrical process?

A. No, not all; but it was our practice usually to treat them and we treated nearly all of them and thought them improved by treatment, but we also treated them sometimes and frequently in order to get conductors of the same electrical resistance.

1625 x-Q. As a rule this electrical treatment was done by Sawyer?

A. Yes, sir.

1626 x-Q. In treating these fibrous carbons by this
2919 electrical process, to what extent was this treatment carried on; I do not refer to the number of fibrous carbons treated, but to the extent of the treatment of such as were treated?

A. In some cases the treatment was very slight, hardly preceptible except under the glass: in other cases the treatment was carried on and repeated until sufficient deposit of carbon had been made to serve as a conductor after the removal of the original carbon and the deposit carbon conductor thus formed was
2920 sometimes by us split or cut into two or three conductors lengthwise and re-treated to make them of the size and resistance required; the treatment which we gave to the carbon was all the way from the extremely slight treatment I have first mentioned to the extremely extensive treatment I have last mentioned; I do not remember carbons made from any other fibrous substances than paper and wood with this extremely large

2921 treatment and most of those so largely treated were of wood carbon, some few of paper carbon cut in the form of arches.

1627 x-Q. In some cases I understand you treated to such an extent only as would make several carbons of uniform resistance and in other cases would treat for the purpose of improving the carbon irrespective of the question of resistance?

A. Yes, and in some cases to manufacture conductors of pure deposit carbon.

1628 x-Q. Where you desired simply to improve 2922
the carbon, the question of resistance being not involved, what was the extent of the treatment?

A. We tried all kinds and extents of treatment for the purpose of improving the conductors from the slightest to the highest.

1629 x-Q. Was there any extent of treatment which was deemed best while you were at 43 Centre street?

A. Yes, I think there was; we had found while we were at 43 Centre street, I think, that the deposit carbon had a tendency to fly to pieces or break like glass 2923
when suddenly heated up; we had found that carbons largely treated with deposit carbon were liable also to fly to pieces in the same manner, when suddenly heated up; or if the current was not turned on to them gradually, but that fibrous carbons less treated were not liable to do so; for this reason we thought it best not to treat the carbons too much, but I do not think I could describe, at the present time, the extent of treatment that we thought best; the extent of the treatment that we thought best simply gave a silvery 2924
or lustrous appearance to the carbon, instead of being black, as it was before treatment.

1630 x-Q. Was the resistance of the carbon reduced in proportion to the extent of the treatment?

A. Yes.

1631 x-Q. I quote from the testimony of Mr. Saw-

2925 yer, in the interference between Edison and Sawyer-Man.

Cross-question and answer 42:

> "42 x-Q. As a matter of fact, about how much was the resistance reduced?
>
> "A. Mr. Man's idea and mine upon that question of resistance began to differ,
> 2926 that is to say, my theory that the most perfect electric lamp would be one in which the incandescent conductor had the highest resistance and the least transverse mass was gradually abandoned by myself, while largely retained by Mr. Man; my present theory being that the most perfect electric lamp is one in which the incandescent conductor has not only the least transverse mass, but the least resistance; I
> 2927 soon began to reduce the resistance of my carbons to as low as an ohm; at present I make them only ¼ ohm, therefore I would treat the carbons so as to obtain a heavy deposit; judging from the difficulty in getting the current through some of Mr. Man's carbons, treated according to his ideas, they must have had as high as 100 ohms resistance, but I don't recollect whether we made measurements of any particular ones; an-
> 2928 swering the question directly, I should say that Mr. Man reduced the resistance in his carbons from fifty to seventy-five per cent. by the treatment referred to; this is an estimate, and not the result of measurements."

Is it your recollection that Mr. Sawyer's statement in the above testimony is correct?

A. I have no means of ascertaining or judging; I assume that Mr. Sawyer's statement, in regard to the

reduction of resistance, has reference to an average 2929
or usual thing; if it is taken in that sense, I could not say that Mr. Sawyer's statement is not correct, but I I would judge, and I think I know, that in many cases the resistance of conductors treated was not reduced either fifty or seventy-five per cent., nor even three or five per cent., but I do not understand that Mr. Sawyer was speaking of anything but average practice.

1632 x-Q. Sawyer, as I understand, actually did the treatment; do you know the extent to which he 2930
usually treated where the desire was to improve the carbon?

A. Mr Sawyer usually did the treatment, but I think not always—almost always; he frequently treated carbons while I was present, and under my suggestion as to the extent of treatment; as I said before, I have have no means of judging of the extent of average treatment, or at least nothing occurs to me now by which I can satisfactorily to myself make such judgment; I do not mean to criticise Mr. Sawyer's 2931
statement of what he thought it was at the time when he gave that testimony, and assume that he gave it as nearly as he could correctly from his then recollection, and the matter called to his attention by questioning; I, therefore, would acquiesce in Mr. Sawyer's statement of his average treatment, but I could not say what actual treatment Mr. Sawyer gave at different times, for the purpose of improving the conductor, as any treatment would, as we then considered, be an improvement. 2932

1633 x-Q. Was there no point ar which you considered the treatment had shown the most beneficial effect?

Adjourned till Monday, the 5th day of December, next at 10½ A. M.

2933

MONDAY, December 5, 1887.

Adjourned till Tuesday, the 6th inst., at 10½ A. M.

NEW YORK, December 6, 1887.

Met pursuant to adjournment.

Present—Counsel as before, and cross-examination of Mr. Man continued as followed:

2934 Witness answers the last quesion of the previous session:

A. There was a point at which we considered the treatment most beneficial; as I have stated, the treatment could be carried to the extent of making the conductors substantially of pure deposit carbon or like one of pure deposit carbon; now we considered that the deposit carbon as carbon was the purest and best carbon, but conductors made of such carbon
2935 were in practice liable to objection, principally for the reason that the carbon being amorphous and dense like glass or possibly crystalline in structure was liable to fly to piecesand break as glass does when suddenly heated up, especially if the carbon was of any considerable cross section, and of less or very small cross section was liable to fracture in handling and manipulating as well as in use in the lamp; for that reason, as I have stated, and for the other reasons I have stated, among others, ease and practicability of manufacture and cheapness,
2936 we preferred in practice a fibrous carbon which was not liable to fly to pieces or break when suddenly heated up; the point then which we considered most advantageous in treatment of the fibrous carbons was that extent of treatment, which, while driving out the occluded gases and purifying the fibrous carbon in the treatment, would not interfere with or destroy the fibrous structure of the carbon, but would leave it still

2937

a fibrous or structural carbon with nothing but pure carbon added to it and that not to an extent to interfere with the advantages of the fibrous or structural character of the conductor, nor to render it liable to the disadvantages of the deposit carbon, of which I have spoken; this condition being observed there was another point in the treatment having reference to the resistance of the conductor; first, to treat to a sufficient extent to render the resistance of the conductor uniform throughout its length, and secondly, to con- 2938
form the resistance of different conductors to the same standard so that they would be equal or substantially so in resistance.

1634 x-Q. What were the advantages of the fibrous or structural character of the carbon which you desired to preserve?

A. I think I have pointed out these advantages fully before; they were mainly as I conceived them, flexibility, elasticity and strength, due to the fibrous arrangement, possibly to the structure of the material of 2938
which the carbon was made, being produced by a process of nature and some arrangement of molecules or atoms in such process.

1635 x-Q. Was the treatment carried on to an extent sufficient to fill up the pores of the carbon or coat its surface?

A. Yes, to some extent, but that extent in the use of our fibrous carbons, as fibrous carbon conductors was not carried so far as to completely or considerably fill up the pores, and after treatment the appearance 2940
of the carbon as to size, dimensions and fibrous character, remained apparently the same as before treatment, but the carbon was rendered more dense and harder, and had under the glass a lustrous or silvery appearance; in cases where we desired to render the carbon more of the character of the deposit carbon conductor, the treatment was carried further, the pores

2941
were more filled up; in some cases as fully as we could do so, and the conductor was increased in size; these we considered substantially deposit carbon conductors, and they were to some extent liable to the objections of which I have spoken of deposit carbon conductors, but not as liable to those objections as conductors made solely and entirely of deposit carbon.

1636 x-Q. In this treatment were the pores filled up before the surface of the carbon became coated?

A. In the treatment the first and most rapid action
2942 was at that point of the conductor in its length having the highest resistance; the coating on the conductor went on evidently upon the individual fibres, whether within the body of the conductor or lying upon the outside of the conductor; if the treatment was properly conducted, when the treatment was carried so far as to bridge over the spaces between the fibres, or substantially bridge over such spaces, the coating or deposit of carbon went only upon the outside of the conductor, and if the treatment were not properly con-
2943 ducted, or was conducted for that purpose, the coating would bridge over between the outer fibres of the conductor almost immediately, and the pores or spaces between the fibres would not be filled up.

1637 x-Q. Then, as I understand you, the treatment would fill up the pores and coat the outside, or coat the outside and not fill up the pores according as the treatment was conducted?

A. Yes, except that in any treatment there must have been some filling up of pores, but the process as
2944 a whole would be as I say.

1638 x-Q. Which did you do in practice?

A. We did both.

1639 x-Q. Which was the proper way of treating?

A. Both were proper, but for different purposes. For the purpose of producing or improving the fibrous conductor, the first method of treatment was the proper one, carried only to the extent I have mentioned, as

2945
the best for the production of fibrous carbon. For the purpose of producing a conductor of pure deposit carbon, the process by which the deposit went on mainly on the outside of the conductor was the proper one, and for the purpose of producing a carbon, having mainly the character of a pure deposit carbon, but with a core of fibrous carbon left in it, the second process, by which the deposit went on mainly on the outside of the conductor, was the proper one.

1640 x-Q. As I understand then, by the use of this 2946
treatment you obtained three characters of carbon? first, a fibrous carbon treated as you describe; second, a fibrous carbon treated to such an extent that the original carbon simply acted as a core for a shell of deposit carbon; and thirdly, a deposit carbon pure and simple, from which the fibrous carbon was removed?

A. Yes.

1641 x-Q. Was the second carbon liable to fracture or fly to pieces? 2947

A. More liable than the first and not as liable as the last.

1642 x-Q. As between the first and second, which did you consider the best carbon, eliminating the question of liability to fracture from consideration?

A. In some forms of our lamps we preferred the first and in some forms the second, simply for mechanical reasons. As a whole we preferred for the incandescent conductor of the lamp, as I have stated very fully heretofore, the conductor of fibrous carbon, which is 2948
the first.

1643 x-Q. I call your attention to the following question and answer of yourself in the interference proceeding:

> "Q. Then as I understand you, there was no objections to the burner made of the paper carbon?

2949

"A. Yes; there were objection at first; it was too fragile; it was not good enough conductor for the electro dynamo machine which we used. The burner had too high resistance. When carbonized with a current, it was liable to crack and to break from contraction. But it had advantages at the same time which we were trying to secure and were working for. When made of pure cellulose, it was a pure carbon, which we were trying in every way to
2950 obtain. That is why we kept working at it and finally succeeded in overcoming all its objections?"

From this testimony it would seem that you considered a paper carbon, pure and simple, as being too fragile and as having a too high resistance but that you considered it a pure carbon and so kept working with it until you had finally overcome all its objections. Is such the fact, and if so, how were the objections over-
2951 come by the treatment to which you have been referring?

Objected to as incompetent; it being a mere fragment of the deposition referred to and as immaterial, having no bearing upon the issue in controversy.

A. Your statement is not a fair statement or conclusion from the testimony you have quoted; you generalized from a particular statement and ask me to adopt
2952 your generalization in answering. I do not desire to change the answer you have quoted, and if your question relates solely to the particulars of that answer I will reply, but I cannot adopt your generalization; I speak in that answer of the difficulties of using the paper carbon with us at first only; if you ask how we overcame these difficulties, I can tell you some of the things which we did, perhaps not all.

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1644 x-Q. In your first use of paper did you find that it was too fragile?

A. As the conductors were made by us, at first, yes.

1645 x-Q. How did you obviate that defect, if at all?

A. In part by cutting the conductors to shape and size before carbonization; in part, by better carbonization of the conductors so cut to shape and size and in part by modifying our lamps; in part we rendered the conductors sometimes and usually, but not always, less fragile by an electrical treatment. 2954

1646 x-Q. Did the electrical treatment make the conductors less fragile?

A. Yes, harder and denser.

1647 x-Q. I quote from the testimony of Wm. E. Sawyer in the interference.

"15 Q. Referring now to the paper carbons, some of which are represented in the sketch Sawyer Exhibit No. 6, state whether or not you put them in a sealed lamp and tested their practicability? 2955

"Yes, sir, we did.

"16 Q. Did you try any of the carbons illustrated by the drawing Sawyer Exhibit No. 6, and if so, which of them?

"A. The carbons shown in Figs. 1, 2 and 3 and the half circle, were positively used; were sealed up and run; the great trouble with them was when we raised the temperature till we could get a bright light they would break; 2956
for this reason I preferred the harder carbons; we finally made them hard enough by treating them in hydro-carbon gas by the Sawyer-Man process."

Is it true that in the early use of carbons made from paper "the great trouble with them was when we (you) raised the temperature till we (you) could get a bright light they would break?"

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A. In the early use of the paper carbons I remember trouble with their breaking: we attempted to run them up, I think now, to too high incandescence, and our lamps and holders were not all adapted to their use.

1648 x-Q. Sawyer in this testimony says: "For this reason I preferred the harder carbons: we finally made them hard enough by treating them in hydro-carbon gas by the Sawyer-Man process." Is that your recol-
2958 lection of the fact?

A. My recollection is that we did treat them with this object in view, and that those so treated were successful in use, but it is also my recollection that some, not treated, were also successful in use; I understand Mr. Sawyer to be speaking in a general way of the subject matter there, and in such a way, his testimony is correct.

1649 x-Q. Did you in your early experiments find that the paper carbon, pure and simple, was not a good
2959 enough conductor for your dynamo machine; that such a burner had too high a resistance?

A. Yes; we found that the paper carbons we made in our early experiments were of too high a resistance for the current of the dynamo we were using, and we had to get increased electro-motive force to pass sufficient current through them to heat them up to incandescence.

1650 x-Q. You remember that fact distinctly, do you?

2960 A. Yes, sir.

1651 x-Q. Which did you do, increase your electro-motive force or decrease the resistance of your conductors?

A. We did both.

1652 x-Q. How did you increase your electro-motive force by getting another machine?

A. We increased our electro-motive force, in some instances, by rapidly making and breaking connection

in a short circuit shunt between the poles of the 2961
machine, and in some instances we charged the field magnet of one machine by a current from another; we varied the velocity of the armature, getting higher velocity than we could usually attain by waiting until after the other machinery in the building where we were was stopped, and then using the increased velocity of the pulleys in the building with which the machine was connected; we used sometimes, I think, with
these paper carbons at first the current from the arc 2962
lighting machine of Arnoux and Hochausen in the basement.

1653 x-Q. Would the expedients you mentioned in your last answer serve for the conduct of any experiments that would give you any valauble information in regard to the conductors?

A. Yes.

1654 x-Q. Could you run a conductor to incandescence for any length of time by the use of these ex-
pedients? 2963

A. Yes, by some of them.

1655 x-Q. By which?

A. By the coupling up of two or more machines—by increased velocity of the armature, or by the use of the arc lighting machine having a higher electro-motive force than the others.

1656 x-Q. How much could you increase the electro-motive force by coupling up the machine or increasing the velocity of the armature?

A. I don't know—enough, so that we passed the 2964
current through the paper carbons and heated them up.

1657 x-Q. Did you continue to resort to these expedients, and thus continue these experiments on these high resistance carbons, or did you abandon experiments on them and work with carbons suited to your machine?

2965 A. We reduced their resistance by treatment, and by making them larger, until they would serve as conductors with the currents we had available, but we frequently had not sufficient current, and had to wait until the other machinery was stopped before we could run our lamps.

1658 x-Q. Do you mean to be understood that you gave up the use of carbons of such resistance as to be beyond the normal capacity of your machines?

A. Of course we used carbons mainly that were suit-
2966 ed to the capacity of our machines; I do not think that we gave up experiments in making carbons while we were there at 43 Centre street.

1659 x-Q. What you did do, then, as I understand, was to bring the resistance of the carbon down to the capacity of the machine?

A. Yes; that, and to arrange and run the machines to the carbons, chiefly reducing the resistance of the carbons to the normal capacity of the machines.

1660 x-Q. If you had designed conducting experi-
2967 ments to any extent on carbons whose resistance was beyond the normal capacity of the machines, the proper thing to have done would have been to have got a machine of greater electro-motive force.

A. It would be the proper thing to do to get a machine of greater electro-motive force for the conduct of experiments on carbons of very high resistance, but it would not indicate that we did not design to conduct such experiments that we failed to get such a machine; it will be borne in mind that we were at work
2968 upon other things than the carbon conductors of our lamps.

1661 x-Q. You have said that in your early experiments you found the resistance of the paper carbon conductors too high, and reduced the resistance. How did you reduce the resistance?

A. We made them larger and shorter, and we treat-

ed them by the electrical treatment and by soaking 2969
them in sugar, etc., and re-carbonizing them or soaking them, as I have explained.

1662 x-Q. Which of these methods did you generally or finally adopt?

A. We almost always treated them by the electrical process, but not always by any process, and I think all the processes were practiced more or less up to March, 1879, not, however, after we left 43 Centre street, ordi-
narily with a view to reduce the resistance, but to im- 2970
prove the conductor.

1663 x-Q. In view of the fact that you found your first carbons of too high resistance, and reduced the resistance as you have stated, can you tell me the dimensions of the carbons whose resistance were too high, and what size you had to make them, and to what extent you had to treat them to bring them within the normal capacity of your machine. I am referring to the time you were at 43 Centre street.

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Objected to as mere repetition, as this subject matter has been all gone over in this examination once, if not twice.

A. Our carbons were usually made of a resistance equal to a well-made deposit carbon, of deposit carbon pure and simple, or conductor, of a length of from half an inch to three-quarters of an inch, and a twentieth of an inch in diameter; some of them that we made
were of a great many times this resistance—how many 2972
I can't say—and some of them were many times less this resistance, and we prepared the fibrous carbons, giving to them all these kinds of resistance, but we usually used them of about the same resistance I have stated of the deposit carbon of the length and size stated.

1661 x-Q. Which did you find in practice the more

2973 durable carbon—the fibrous carbon treated by your electrical process or the carbon not treated?

A. I think all the carbons were improved by the electrical treatment and rendered more durable, and I think they are to-day so improved by such treatment.

1665 x-Q. It appears, by the record in the Sawyer-Man-Edison Interference, that Mr. Broadnax asked Mr. Sawyer the following question, and received the following answer, referring to the use of paper carbon:

2974 "Q. How long did they last in the lamp?

"A. Untreated by the Sawyer-Man process would last from one second to ten minutes, if run up to give a good bright light; if run at a low temperature, they would run anywhere from one hour to a hundred hours; it depends entirely upon the temperature."

Is it your recollection that while at 43 Centre street paper carbons, which had not been treated by the Saw-
2975 yer-Man process, would last if run up to give a good bright light from one second to ten minutes?

A. It is my recollection that while at 43 Centre street, and indeed up to March, 1879, we usually ran our carbons up to very high incandescence—much higher than the incandescent lamps of to-day are run, so high that a single lamp would illuminate a large, dark room, with rough walls and ceilings, of about twenty by forty feet in size and about ten or eleven feet high, which was the character of our room at 43
2976 Centre street, and I take it that that is what Mr. Sawyer means by a good bright light; if such interpretation were put upon his testimony I fully agree with him; I know that many of our paper carbons untreated were destroyed as Mr. Sawyer states, but many others untreated run at low incandescence, giving a fair light, lasted the longer times, he states.

1666 x-Q. Was this high incandescence at which

you usually run them the degree of incandescence which you then considered proper or desirable? 2977

A. Yes; I think we had some idea of competing with arc lamps.

1667 x-Q. Is it the fact then that the life of these untreated paper carbons when run to the degree of incandescence which you then thought proper or desirable was from one second to ten minutes?

A. Yes, usually.

1668 x-Q. On cross-examination the following question was asked and the following answer was made by Mr. Sawyer: 2978

"49 x-Q. Referring now to your 17 answer, could a lamp as described there which would burn from one second to ten minutes be used in competition with gas or other commercial lights?

"A. It could not; and at that time the invention was not so perfected in all respects, including the inclosing globe and machanism as to make the lamp suitable for any practical purpose; by mechanism I mean the general construction of the lamp, method of sealing conductors, &c.; 'that is, all the attachments of the lamp and the general mechanical construction of the lamp.'" 2979

Do you agree in the opinion of Mr. Sawyer and is the statement of facts made in the answer true according to your recollection?

A. I would agree to the statement until the latter part of the time we were at 43 Centre street; my opinion is that some of the lamps we had when we left 43 Centre street, were supplied with fibrous carbon and were good commercial lamps considering the then state of the art of incandescent electric lighting. 2980

1669 x-Q. The following question was asked and the following answer made by Mr. Sawyer in the interference referred to:

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"18 x-Q. State as near as you can recollect how long the best of the paper carbons you made at 43 Centre street would last in the lamp when raised to a temperature high enough to give a good bright light, after having been trea by the Sawyer-Man process?

"A. Run at a power of about 25 candles, they would last from five to 100 hours; once in a while we would get a lamp so perfect in every respect that it would seem to undergo
2982 no change after a long use, but generally they would fracture in 5 to 20 hours, run at that temperature; the difference in the duration of the burners was due to both imperfection in the lamp and in the carbon; where the fracture alone occurs it must be due either to imperfection in the carbon or the effect of unequal expansions; when consumption occurs it is due to the imperfect charging of the lamp."

2983 Is it your recollection that the treated paper carbons when run at about twenty-five candles, would generally last from five to twenty hours?

A. I can only say that my present recollection of it is not sufficient for me to state, but I have no reason to criticize Mr. Sawyer's statement taken as a whole, and think it is probably as nearly accurate as he could give it.

1670 x-Q. On cross-examination in the interference referred to, the following question was asked of Mr.
2984 Sawyer and answer given:

"50 x-Q. Referring now to your 18 answer, could a lamp as described there which would burn from five to one hundred hours be used in competition with gas or other commercial lights?

"A. I think not."

Is such your opinion?

2985

A. No; there are situations and places where such a lamp would drive out the use of gas in my opinion, and it would depend upon the facilities at hand or available for restoring such lamps, as is the case with the arc light, whether it could compete with the gas or not, commercially; in some places it could, in others it could not so compete, in my opinion.

Adjourned till Thursday, the 8th inst., at $10\frac{1}{2}$ A. M.

2986

THURSDAY, DEC. 8, 1887.

Met pursuant to adjournment.

Present: Counsel as before, and the cross-examination of Mr. Man was continued as follows:

1671 x-Q. Referring to the specimens of excelsior,
manilla, and broom corn offered in evidence, did you 2987
ever make a lamp in which the carbon was made of manilla fibre?

A. I do not know; we tried such carbons in our lamps but I don't know whether we made a successful lamp with it or not.

1672 x-Q. Why do you not know?

A. Simply because I do not recollect.

1673 x-Q. Do you recollect running any of such carbons to incandescence?

A. Yes, I recollect of carbonizing them and try- 2988
ing it.

1674 x-Q. Did you get a current through?

A. Yes, I think through the single fibres of short lengths; I know we did through the twisted fibres or strings of the same, I mean of manilla.

1675 x-Q. How short were these single fibres?

A. I don't think more than a quarter of an inch long

2989 between the holders; they may have been longer, but I judge not.

1676 x-Q. How did you support these single fibres in the holders?

A. The ends were placed in clamps at the tops of the holders.

1677 x-Q. What sort of an atmosphere did you use in the lamps where these were tried?

A. Hydro-carbon gas, hydrogen and nitrogen were
2990 the gases that we were using and all our trials were made in one or more of these gases or in a vacua of those gases.

1678 x-Q. How long did you get any one of these single manilla fibres to remain incandescent?

A. I don't recollect.

1679 x-Q. Can you give no idea?

A. No, I canno .

1680 Did you have a machine which would, when worked to its normal capacity, render them incandes-
2991 cent?

A. Of short lengths.

1681 x-Q. Were they delicate carbons to handle and place in the lamps?

A. Yes.

1682 x-Q. How did they compare in your estimation with the larger and harder carbons?

A. I do not recollect; the carbon of manilla fibre was a hard carbon comparatively.

1683 x-Q. Did ever make a lamp in which the con-
2992 ductor was made of manilla fibre?

A. I do not recollect that we made any lamps in which the carbon was of single manilla fibre, though we tried it by way of experiment; we did make some in which the carbon was of twisted manilla fibre in the form of loops; they did not last any better, if as well, as the the paper and wood carbons: they were more difficult to make and use and we did not continue to make them, preferring the others.

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1684 Is what you have said of manilla equally true of jute?

A. It is, except that that we did not like the jute as well as the manilla.

1685 x-Q. What were the endogenous woods you carbonized?

A. I don't know, and I don't know whether I knew at the time; we got them to carbonize by reason of our thinking that their interlacing fibers might be an
advantage. 2994

1686 x-Q. What endogenous woods have interlacing fibres?

A. I don't know; I think the palms and the other larger growths of endogenous woods.

1687 x-Q. Did you ever make a lamp in which the carbon was made of endogenous wood?

A. Yes, we simply did it, though, by way of experiment.

1688 x-Q. Did you ever try excelsior in a lamp?

A. Yes. 2995

1689 x-Q. With what success.

A. The excelsior carbons were mostly too fine and high resistance for our current, and we did not make much use of them; we carbonized them and tried them in the arch form, but had to make the arches too flat of it to satisfy us; its use was experimental.

1690 x-Q. Did you ever try the broom corn in a lamp?

A. Yes; either while at 43 Centre street or at the
corner of Walker and Elm streets, I can't recollect 2996
which.

1691 x-Q. With what success.

A. We bent and carbonized broom corn in the form of loops, for conductors, but I do not think we saw any advantage in it, and I remember it only as a thing we tried experimentally.

1692 x-Q. The patent in suit mentions the use of a

2997 vacuum, and you have, throughout your deposition, mentioned the use of a vacuum in your lamps, or the use of an attenuated atmosphere of some non-combustion supporting gas; what means had you, at 43 Centre street, for supporting a vacuum?

A. We had an air pump, worked by hand, and we also used an exhausting apparatus with mercury.

1693 x-Q. Where did you get the hand pump?

A. We borrowed it, or Sawyer did; I don't recollect where, if I knew, or from whom.

2998 1694 x-Q. About how long after you had been to Centre street was it borrowed?

A. I cannot recollect, but I should judge a week or so, or two weeks; it may have been sooner.

1695 x-Q. Did you have the continuous use of this pump while you were at Centre street?

A. I don't know; we had the use of a pump, this or others, while there; I do not recollect about it, because I did not personally get or borrow the pumps or pump.

1696 x-Q. You speak of "pumps," were more than
2999 one borrowed?

A. I don't know whether the same pump remained there all the time after we borrowed it, or whether it was borrowed more than once, or whether other pumps were borrowed.

1697 x-Q. Do you remember whether you had the continuous use of a hand pump?

A. No; I only remember using it when we wanted to.

1698 x-Q. Do you remember whether you always
3000 had it there to use when you wanted to?

A. I do not remember whether we always had it there or not.

1699 x-Q. What was the exhausting apparatus used with mercury?

A. It was of the character of a Geissler pump, used by displacement of air by mercury.

1700 x-Q. Where did you get this apparatus?

3001

A. We rigged it up ourselves.

1701 x-Q. By "ourselves" who do you mean?

A. Mr. Sawyer and I.

1702 x-Q. Where did you get the parts which you thus rigged up?

A. I forget; I think though that I got the reservoir either from Haggerty Brothers in Platt street, or from the glass house in Brooklyn; it was the one lying south of the South Seventh street ferry; a continuation of the street running north and south by that ferry and 3002
several blocks south of the ferry, or to the right hand as you cross the ferry from New York.

1703 x-Q. Where did you get the glass tubing and stop-cocks?

A. I don't know; we bought such at a variety of places, among others from Frasse, in Chatham and Fulton streets, New York; from Hahn, in North William street; from the glass factory I have mentioned, and perhaps at other places, and I had some at my house which I brought over and used. 3003

1704 x-Q. Did you have any glass blower assist you in putting the apparatus up?

A. No; we put it up ourselves.

1705 x-Q. Did you individually possess sufficient skill to put the apparatus up?

A. Yes; it required no great skill.

1706 x-Q. Please describe in detail this apparatus, and state when it was put and where in the room?

A. The apparatus I cannot describe in its minute details; generally it was a glass reservoir with three 3004
outlets, one to the open air on top with a stop-cock in it, two at or near the bottom of the reservoir with stop-cocks, one connecting to the lamp chamber through glass and rubber tubing, the other to a bottle having two outlets, one at the top and the other near the bottom; the last bottle was larger than the reservoir I first spoke of; it was used in different places in

the room; the apparatus was put up soon after the purchase of the mercury shown by ——; that purchase, as appears by my check book, was paid for to Charles P. Pfizer & Co., April 6, 1878; the stop-cocks were of glass and bought of Mr. Hahn in North William street; the usual place of working this apparatus was on a bench in a little room partitioned off from the main room by a canvas partition.

1707 x-Q. Did you use this apparatus to any extent
3006 for obtaining a vacuum?

A. Yes; we used it frequently, not always.

1708 x-Q. Could you get a vacuum with it?

A. Yes; very good.

1709 x-Q. Better than with the hand pump?

A. Yes; much better.

1710 x-Q. Were you troubled with mercury vapor?

A. I don't know; I don't recollect.

1711 x-Q. You remember no trouble of that kind?

A. I don't remember observing any.

3007 1712 x-Q. Did you have any trouble with it?

A. I don't recollect any trouble with it except in keeping the joints tight and in bursting a rubber tube connecting between the two reservoirs and bottle.

1713 x-Q. How did you keep the joints tight?

A. We covered them with rubber tubing and tied them over with strings.

1714 x-Q. Did Sawyer ever complain of this apparatus as creating a mercury vapor?

A. I don't remember; we might have had trouble of
3008 that kind and Sawyer may have complained of it, but I do not recollect that he did.

1715 x-Q. Do you remember taking any precautions to avoid the creation of a mercury vapor?

A. I do not.

1716 x-Q. Had you ever tried such an exhausting apparatus before?

A. Yes.

3009

1717 x-Q. Where.

A. I don't know.

1718 x-Q. Do you know whether Sawyer ever had?

A. I don't know; I only know it was not new to me and I don't think it was to Sawyer.

1719 x-Q. Is it then the fact that you put this apparatus up and that it had worked successfully from the start?

A. Yes, we put it up, had some trouble with the bursting of tubes or rubber tubing, and it worked well 3010
enough for our purposes.

1720 x-Q. Which did you prefer, a vacuum or an inert gas at atmospheric pressure for your lamps?

A. We were most successful with an atmosphere of inert gas at atmospheric pressure, as compared with the vacua that we obtained without the gas, but I think we preferred a vacuum or partial vacuum of inert gas to either.

1721 x-Q. Don't you know which you preferred? 3011

A. I do not remember exercising ourselves in regard to it; I think clearly that we preferred the inert gas at atmospheric pressure to an atmospheric vacuum such as we obtained. By "atmospheric" I mean such a vacuum as contained no inert gas, or remnants thereof, but only a remnant of atmospheric air.

1722 x-Q. As between an inert atmosphere at atmospheric pressure, or a vacuum where the residual atmosphere was an inert gas, which did you prefer?

A. We very rarely had, if ever, an atmosphere in our lamps when they were finally closed up at atmospheric 3012
pressure, but somewhat less than that. I do not remember that while we were at 43 Centre street we had formed any decided preference as to the degree of pressure or attenuation of the atmosphere of our lamps; it was only, as I think now, after we went to the corner of Walker and Elm streets that we began to think that it was a possible advantage to reduce the amount of

3013
gas in the lamps. Still, I may be mistaken in this, but I think not.

1723 x-Q. Did you ever form a preference for either?

A. Yes. I think while at the corner of Walker and Elm streets, in the Fall of 1878; at all events we practiced extensively the exhaustion of the air of our lamps.

1724 x-Q. You say you "think;" do you mean that you are in doubt as to whether you did?

3014 A. No, I don't think I am in doubt in regard to it;
I think we preferred clearly and distinctly the exhausted chamber, but there were other questions connected with the matter that complicate the matter in my mind.

1725 x-Q. I do not understand whether you are clear as to whether you preferred one over the other, or are merely conjecturing in regard to it. Did you have a distinct preference at any time?

A. Yes; we did have a theoretically distinct prefer-
3015 ence in regard to the matter is what I mean to say.

1726 x-Q. What do you mean by "theoretically"?

A. We recognized the fact that any atmosphere with which we could fill the lamp could not be a perfectly inert atmosphere. We also recognized the fact that a perfect vacuum would be. The complication of which I have spoken has reference to our practical difficulties in getting even an approximation to such a vacuum, and then sealing up our lamps and having the vacuum preserved in them.

3016 1727 x-Q. You say you recognized these difficulties.
Now, as a practical question, did you ever reach any preference?

A. Yes.

1728 x-Q. Which was it for?

A. It was for an attenuated atmosphere in an inert gas.

1729 x-Q. Attenuated to what extent?

A. We tried all extents from slightly below atmos- 3017
pheric pressure, perhaps a third of the pressure removed, up to the highest that we could get; we had difficulty in preserving while sealing up the higher attenuation, and we adopted ordinarily in practice therefore, a less attenuation than the highest that we could get, as an ordinary thing.

1730 x-Q. Can you give me any idea as to the degree of attenuation which you preferred?

A. No. I don't recollect. I don't think we could
know what the degree of attenuation was, but only 3018
the pressure of the atmosphere in the lamp which was always hot when sealing it up; my idea would be now that we ordinarily reduced the pressure perhaps a half, perhaps more, perhaps not so much, perhaps only a third, from a third to two-thirds, and it was still further reduced when the lamp was cooled off; this was only in lamps in which we were endeavoring to have a vacuum or partial vacuum; in much the greater number of our lamps we
used the pumps only as a method of exhausting the air 3019
and for filling the lamps with the inert gases; so that they were more nearly at atmospheric pressure than the others.

Adjourned till Friday, the 9th inst., at 10½ A. M.

Friday, December 9, 1887.

Met. Present—Counsel as before and the cross-ex- 3020
amination of Mr. Man was continued as follows:

1731 x-Q. Aside from the fact that no inert atmosphere is absolutely inert toward carbon when incandescent, were you of the opinion that it was disadvantageous in any other respect?

A. There are certain degrees of vacua in which the

3021 current seems to be transmitted, whether conducted I cannot say, in the manner of the Geissler tube, and certain degrees of exhaustion in which the electric arc seems to be more readily established than in a plenum at ordinary atmospheric pressure or in a high vacuum; a higher exhaustion and a less exhaustion do not have the same results in these particulars; again, the higher the exhaustion the less the conduction of heat by the atmosphere of the lamp; again, the higher the exhaus-
3022 tion the less the wearing away of the conductor by the impingement of the atoms of the air or atmosphere against the conductors, sometimes called the bombardment of atoms, referred to in the Kinetic theory of gases.

1732 x-Q. Did you recognize these facts at the time of your experiments?

A. We did.

1733 x-Q. What effect had the conduction of heat on the candle power of the lamp?

3023 A. Of course to the extent that heat was conducted away from the incandescent portion, the candle power of the lamp was diminished; I do not mean by this that the loss in candle power was an exact fixed ratio to the loss of heat from the conductors; the ratio would increase as the loss of heat increased.

1734 x-Q. Would now current then be required to bring the lamp up to incandescence?

A. It would.

1735 x-Q. You recognized that then, a high vacuum,
3024 if it could be first obtained and when maintained, would be preferable to an inert atmosphere?

A. Yes, unless the vacuum was one of inert atmosphere; that is preferable to any other atmosphere.

1736 x-Q. Why then did you not employ a high vacuum of either atmospheric air or an inert gas?

A. We did so employ it, but it was not our ordinary method or practice?

3025

1737 x-Q. Why did you not adopt it as your ordinary method or practice if you knew it to be superior?

A. Because of the difficulty of securing such a vacuum, the long time consumed with our apparatus in getting it and the difficulty of maintaining it when obtained and because we were hurrying to get lamps to exhibit and put in use, and because that our lamps with a very moderate exhaustion and little below the normal pressure of the atmosphere seemed to us good enough for practical use. 3026

1738 x-Q. The patent in suit in its 4th claim, as one of the elements of the combination thereof, speaks of "an illuminating chamber made wholly of glass, hermetically sealed." The specification of the patent speaks of a "lamp chamber" composed wholly of glass as described in the patent 205,143; did you and do you consider the lamp chamber of patent 205,144 as made wholly of glass?

A. Yes.

1739 x-Q. Referring to your answer to questions 50, 3027
51, 52, 53, 54, 55, 56, 57 and 58 of your direct examination do you know of your own knowledge that lamps were made as there described?

A. Yes; I saw them at the place, 94 Walker street.

1740 x-Q. Did you see them made?

A. No.

1741 x-Q. You say but a few were made, about how many?

A. I don't know; three, four or five of them came under my observation at the shop in Walker street. I 3028
had not known of their being made until I saw them, or first his father and then him; his father's time was being taken up with these lamps when he had other work assigned to him; he told me that his son had got them made and directed him to do the work; I asked Mr. Sawyer then in regard to them and he told me he had got them blown at the glass blower's right oppo-

3029 site our shop, or nearly opposite, in Walker street, where we had had some small amount of glass blowing done; the lamps were put up by Mr. Sawyer and he called my attention to them again several times; I don't think I ever saw but one of them at a time lighted up, whether the same lamp or different ones I do not recollect, but I believe different ones.

Defendant's counsel objects to what Sawyer stated to witness as incompetent.

3030 1742 x-Q. Then you where not consulted and did not know as to the making of these lamps.

A. No, not at first; Mr. Sawyer was at the time in charge of the shop and gave directions for the work to be done, usually consulting with me in regard to it beforehand, but in this case he did not.

1743 x-Q. Then you do not know of your own knowledge how these lamps were made except as you inferred from the completed structure or as Sawyer told you.

3031 A. The completed structure showed how they were made and Sawyer also told me.

1744 x-Q. Is your recollection of these lamps clear?

A. Yes, a lamp all used together and not in separate parts.

1745 x-Q. What kind of carbon did they have?

A. The same carbons as our other lamps; I can't recollect whether circular or straight; I think circular.

1746 x-Q. Did they have hollow conductors?

3032 A. Yes, one hollow conductor, not two; I think one of the lamps had a glass tube instead of a metal one; and the conductor in that lamp in the tube was solid, making both conductors solid.

1747 x-Q. Is your recollection clear as to there being such a lamp?

A. Yes, my recollection is clear in regard to it.

1748 x-Q. Please illustrate by a sketch each of these lamps? 3033

A. Figure 2 of patent 317,676 will show the general appearance of one lamp when set up; fig. 5, of the same patent, shows the construction of the bottom of the lamp, the only difference being that the flange *x* of the globe and the base piece *y* were fused together after the interior works of the lamp were set up; the base, *y*, was thinner than as represented in figure 5 of the patent referred to. 3034

Witness makes a sketch.

(Witness continues): I have made a drawing, illustrative of a base of one of the lamps that I saw; there were other constructions what I saw, but I cannot remember them with sufficient accuracy to make drawings of them; in one, I know there were two glass tubes fused in the base into which conductors were fused.

Drawing offered in evidence, and the same 3035
is marked "Defendents' Exhibit, Man drawing Dec. 9th, 1887."

1749 x-Q Referring to the drawing, did the metal conductor C pass out through a hole in the tube A?

A. Yes, through a hole in which it was fused.

1750 x-Q. Did the glass tube A have an open outlet into the interior of the lamp?

A. It did.

1751 x-Q. Was the conductor C sufficiently loose in 3036
the tube A to admit of exhausting or charging the lamp by means of this tube?

A. Yes.

1752 x-Q. What was the material and size of the metal conductor B?

A. I think it was a brass wire; both the conducters B and C at first, I think, were brass wires.

1753 x-Q Why did you say "at first?"

3037 A. Because they afterwards changed it, using an iron wire.

1754 x-Q. In other respects the lamp conformed to the general style, shown in the patent in suit?

A. Yes; one, however, was different, but I cannot recollect it with sufficient accuracy to describe it.

1755 x-Q. The order in which these parts were made or put together you do not know of your own knowledge?

3038 A. Only as I could judge what it was from what I knew of glass-blowing.

1756 x-Q. Have you now testified in answer to my questions, as to all that you remember on this subject?

A. All that occurs to me now.

1757 x-Q. If there was any invention in the doing of what you have just described it was the sole invention of Sawyer, was it not?

A. Neither Mr. Sawyer nor I thought there was any
3039 invention in it; if there was, I did not claim any part of it; if there was any invention, it was his alone, but it belonged to the Electro-Dynamic Light Co., under his agreement with that company.

1758 x-Q. Was the character of construction followed up in any way?

A. No more than those few lamps, so far as I know.

1759 xQ. You say in your 49th answer that Exhibit No. 29 was blown directly from the pot in your presence; was it blown in a mould?

3040 A. No.

1760 x-Q. Was any commercial use made of the lamps you have described previous to my last question, I mean those having the glass bottom plate fused on to the globe?

A. The only use that was made of them was to set them up in our shops and run them for lighting up the place and show them to people who came in, so far as I know.

3041

1761 x-Q. Your usual method was to clamp the parts and not fuse them?

A. It was.

1762 x-Q. You preferred the clamping?

A. I think we did; we preferred to fit them together so that we could take them apart and renew the carbons, and re-charge them or exhaust them.

Adjourned till Monday, 12th inst., at 10½ A. M.

3042

MONDAY, December 12, 1887.

Met pursuant to adjournment.

Present—Counsel as before; and the cross-examination of MR. MAN was continued, as follows:

1763 x-Q. In answer to your 87th question, referring to the use of the soapstone disk:

> "We subsequently ascertained that it was 3043
> "not necessary, and ultimately left it out."

When, in point of time, did you ascertain that it was not necessary?

A. We came to the conclusion while we were at 94 Walker street, in the fall of 1878, that the disk of conducting or insulated material, to which you refer, for the purposes for which it was first introduced, viz: to prevent the radiation of heat, was not necessary, but for the purposes secondly introduced, the serving as a 3044
base of support for the conductors or holders and the incandescent conductor, that it was useful; so long as Mr. Sawyer and I were together, until March or April, 1879, we continued its use for this latter purpose, modifying it in form and shape and materials used.

1764 x-Q. If you considered the disk unnecessary for preventing heat in the fall of 1878, why did you, in

3045 the patent applied for on November 5, describe its use for this purpose and claim it?

A. I think our conclusion that the disk was not a necessity for preventing radiation had not been reached at that time, and possibly not till the winter of 1879: whether it was or not, I do not think, so long as Mr. Sawyer and I worked together, that we were convinced that the disk referred to might not be of some use in preventing the radiation of heat to the base of the lamp.

3046 1765 x-Q. I undersand the fact to be that you and Sawyer always retained it, as a part or the constuction of your lamps, irrespective of the purpose which it served?

A. We did, I think, so long as we worked together up to and into March, 1879, but not of a size to fill the globe of the lamp and prevent radiation, but only as a base for setting up the holders and incandescent conductor.

1766 x-Q. In your 87th answer, referring to this
3047 disk, you say that ultimately it was left out; what do you mean by that statement?

A. I mean that the Eastern Electric Manufacturing Co. and the Consolidated Electric Light Co. left it out as a feature of the lamp, to prevent radiation, and its only remnant in the lamps of the latter company consists in the glass base projected inward into the lamp upon which the holders and incandescent conductors are set up, and which glass base is fused to the walls of the lamp chamber. It appears in Complainant's Ex-
3048 hibit No. 21, in this remnant form.

1767 x-Q. Was not the lamp that you considered you had perfected, when you left Centre street, and the lamp which you designed at that time to introduce commercially, a lamp of large carbon and lower resistance?

A. Yes; I think so.

3049

1768 x-Q. With the exception of such experimental lamps as you made after that period, were not your efforts directed mainly to the improvement of that type of lamp?

A. I think we gave more attention to the making of a lamp of moderate resistance than to attempt to realize the advantages of a lamp of high resistance; for the reason which I have heretofore stated.

1769 x-Q. Is it not true that, so far as there was any difference between the smaller and larger carbons, you 3050
preferred, for the reasons that you have stated, the larger carbons?

A. It is hardly fair to express it in that way. It was not a question of larger carbons or smaller carbons—a question of high or low resistance, but a question of what we could do with the means at our command; and we made mostly the larger carbons, with low resistance, because we could run them—a lot of them together—while we could only run one, or at most two, of the finer carbons with the current at our command. 3051
It was a question, therefore, of making a good lamp, and the question of high resistance or low resistance, as a matter of preference in my mind, I do not think existed. We considered, I believe, that having made good lamps of any suitable resistance for giving proper light, we could make lamps of higher or lower resistance than those we had made, within the limits of practicability and suitable to currents, available for use, of higher or less electro-motive force.

1770 x-Q. But the fact is, is it not, that the ordinary 3052
lamp you built was one that had a comparatively large carbon and low resistance?

A. Yes, in comparison with most of the incandescent electric lamps of the present day. Some of the electric lamps of to-day have carbons of larger cross-section than those we ordinarily used, but I think they are longer and of higher resistance than our carbons usually were.

3053 1771 x-Q. While you were at 43 Centre street, how long, of your own knowledge, did a carbon remain at continuous incandescence? I mean to inquire as to what you yourself know, independent of any statements made to you by others, in regard to the incandescence of the carbon.

A. I saw the same carbons, in the same lamps, without intermission, run for hours at a time; three, four or five hours, or longer; all an evening and all an afternoon, at several different times.

3054 1772 x-Q. It was not your custom to be at Centre street as long as three or four or five hours at a time, was it?

A. No, sir.

1773 x-Q. These, then, were special occasions?

A. Yes, sir.

1774 x-Q. The engine in the building on which you were dependent did not run at night, did it, except by special order?

A. No, sir.

3055 1775 x-Q. On the evenings to which you referred, did you make special arrangements for the running of the engine?

A. We did.

1776 x-Q. Who made these arrangements, and with whom were they made?

A. The engineer. I forget whether by myself or by Mr. Sawyer at any particular time. Sometimes one of us and sometimes the other; usually Mr. Sawyer.

1777 x-Q. What was the occasion of the running at
3056 night?

A. To exhibit our lamps and to run them continuously a longer time than could be done while the engine was usually running.

1778 x-Q. Who were present at these exhibitions at night to which you refer?

A. I do not remember. A large number of people

at different times. I remember Mr. Lawrence Myers being there; Mr. William Hays; Mr. Jacob Hays; Mr. Classon; Mr. Hugh McCulloch; I don't know whether at night or in the daytime; other gentlemen invited there by Mr. Sawyer, whose names I do not recollect, if I knew them; other gentlemen invited there by myself, whose names I cannot recall. 3057

1779 x-Q. Can you mention any gentlemen now present who you *know* were present at one or all of these exhibitions at night? 3058

A. I think all of the gentlemen I have mentioned, with the possible exception of Mr. McCulloch, saw the lamps running at evening. I do not think any of them remained during all the time that the lamps were lighted up. Mr. William H. Church was also present, and saw them running at evening.

1780 x-Q. What I desire to know is, if you are certain, so certain that you do not *think*, but *know*, that some gentlemen now living that were present at any or all of these evening exhibitions. If there is any person 3059
or persons whom you *know* were so present, please mention their names?

A. I have given you the best of my recollection upon this subject. It is ten years, or nearly so, ago. I feel the greatest confidence, and I think I know that all of the gentlemen that I have named, except possibly Mr. McCulloch, were present, and saw the lamps running at evening at 43 Centre street, but I do not claim to be infallible in my recollection. I only say that such is my recollection, and I think I know it. 3060

1781 x-Q. Are you as confident that these gentlemen saw these lamps running at 43 Centre street, as you are of any other fact concerning which you have testified?

A. No; some one or more or these gentlemen might have seen it in the day time and not at evening, and I might be mistaken as to one or more of them, but I think not.

3061 1782 x-Q. As I understand, these were exhibitions to show the lamps running?

A. Some of them were and some of them were not. Some of them were for trial of the lamps.

1783 x-Q. And about how many occasions did you run these lamps at night?

A. I cannot tell; perhaps a dozen times.

1784 x-Q. On each occasion you were dependent upon the power in the building, and had to depend on the engine of the building being run after hours?

3062 A. Yes, but sometimes other people in the shops wanted to work at night, and the engineer would advise us that he was going to run after hours and we could avail ourselves of the opportunity thus furnished.

1785 x-Q. What was the usual time that the power in the building shut down?

A. Six o'clock, I think; it was frequently after dark.

1786 x-Q. How late do you remember running at night?

3063 A. I should think nine or ten o'clock, but not usually later than eight, or from eight to nine.

1787 x-Q. Now, these exhibitions that were made in the evening were exhibitions of completed and running lamps, as I understand?

A. Yes; so far as they were exhibitions.

1788 x-Q. About when did the first of these exhibitions take place?

A. Very soon after we went there to 43 Centre street, within a week or so; Mr. Sawyer invited a number of
3064 gentlemen to see the lamps lighted up after candle light, or they remained after candle light, I don't know which.

1780 x-Q. Do you remember any of the gentlemen who were present at that exhibition?

A. No, I do not.

1790 x-Q. Were you present?

A. During only a part of the time; I left before the rest. 3065

1791 x-Q. The apparatus at this exhibition was, I suppose, comparatively crude?

A. Yes.

1792 x-Q. When was the first exhibition in the evening at 43 Centre street, in which you showed a well-constructed and finished lamp?

A. I think in April, 1878.

1793 x-Q. What was the construction of the lamp exhibited? 3066

A. I can't recollect, because we had various constructions.

1794 x-Q. You mean you exhibited several different constructions of lamps?

A. Yes; mostly lamps with straight pencils or low, flat arches.

1795 x-Q. Were they of the same general construction, differing only in detail, or of radically different construction? 3067

A. They were of the same general construction, except as to the holders and incandescent carbons and leading-in conductors; the shapes of the globes were different in different lamps; some of them were straight and some of them had bulbs.

1796 x-Q. How many lamps did you run at a time at this first exhibition in April?

A. From two to four, probably; at different times we ran different numbers of lamps, sometimes only one and sometimes as many as eight. 3068

1797 x-Q. Were these lamps shown at this first exhibition of the construction shown in Patent 205,144?

A. I cannot distinguish any exhibition in my recollection in the month of April as the first; the lamps shown in our exhibitions were generally similar, but not like it, the respect that the part G shown in the drawing of that patent was usually omitted and a spring

3069 was substituted for the weight of the part F usually; again, many of the lamps which we exhibited had the carbons running cross-wise between the holders, some of them rising in arches above the holders, instead of standing vertically or upright as shown in the drawing of this patent; there is a type shown in figure 8 of the drawings of this patent which is more nearly like the lamps we usually exhibited.

1798 x-Q. In these lamps that you exhibited, what
3070 were the incandescent conductors made of?

A. Referring generally to the lamps shown to different people at different times while we were at 43 Centre street, the incandescent conductors were generally made of mineral carbon or deposit carbon, treated according to our electrical process; some, however, were of fibrous carbon, wood or paper, treated according to our electrical process.

1799 x-Q. To whom were the lamps containing fibrous or paper carbon conductors treated as de-
3071 scribed, exhibited?

A. I do not know; they were simply shown with our other lamps; Mr. Church and old Mr. Sawyer and his son George were the only persons that I think at that time knew of the fibrous carbons being used; others may have known it, but I do not know that others did.

1800 x-Q. Were any lamps containing fibrous paper carbon untreated, exhibited while you were at 43 Centre street?

A. I do not know of any, and I do not know that
3072 they were not; I think and am confident that Mr. Wm. H. Church saw them used and knew what they were, and also Mr. Wm. Sawyer and George Sawyer: of course Mr. Wm. E. Sawyer saw them.

1801 x-Q. Did these gentlemen that you think saw these lamps run, watch them running for any considerable period?

A. I don't know that they timed them; I think Mr.

William H. Church watched their operation, but am 3073
not sure.

1802 x-Q. Was the construction of the lamp and the character of the carbon explained to them?

A. They saw the work going on and knew more or less of what we were doing. Of course in doing the work, more or less explanation, how much I cannot tell now, was necessarily given to Mr. Wm. Sawyer who worked on the lamps and in setting them up, and
assisted generally. Mr. George Sawyer was employed 3074
principally as a messenger in sending in for different things and sometimes as an assistant merely, to his brother and father or to me. How much explanation was given to him I do not know or recollect; he was a boy about 17 or 18 years old or less. The construction of the lamps and the preparation of the carbons was, I think, explained to Mr. Church more or less by Mr. Sawyer or by me, mostly by Mr. Sawyer, I think he was pretty well advised as to what was going on.

1803 x-Q. On the occasion on which you saw the 3075
same carbon run at continual incandescence, for a period of three or four hours, were you present for the purpose of watching the continued burning of the carbon?

A. Sometimes, yes; when we were testing them. Sometimes no, when I was simply at the shop working or assisting or advising and consulting with Mr. Sawyer and the lamps were being run. Sometimes no, when I had invited people to see the lamps and simply
went there and remained because they were there. 3076

1804 x-Q. While at 43 Centre street, what is the longest period that you were told of a lamp being run at continued incandescence?

A. All day, from early morning until evening.

1805 x-Q. As to whether such was the fact depended upon the truth of the statements of the Sawyers?

A. In part yes; but in part confirmed by my own observation in seeing the lamps started or running, and

3077 afterward returning and finding them so, at midday and at evening.

1806 x-Q. But whether they had been running in your absence you do not know?

A. No, not further than I was told by the Sawyers, and I think Church.

1807 x-Q. How many hours of actual incandescence do you, of your own knowledge, know of any one carbon continually burning at 43 Centre street?

A. I cannot give the number of hours. We did not
3078 keep track of them. I saw the same lamps with the same carbons in them run day after day at high incandescence, I should judge from 25 to 50 candle power, or higher sometimes, from some time in April until we left 43 Centre street, the last of May or first of June. They were good then and the carbons seemed not to be affected by their use.

1808 x-Q. How do you know that the carbons had not been changed in your absence?

A. Because of the manner of setting up the lamps,
3079 and the appearance of the carbons themselves, and of the lamps. If they had been changed I should have observed it.

1809 x-Q. You had no reason to suspect that anything of the kind had been done or would be done, had you?

A. No, I knew of the carbons being changed in lamps very frequently, and observed the changes that were made, and observed those that were not changed, and was closely watching the lamps and the effect of
3080 their use upon the carbons.

1811 x-Q. You had no reason to suspect, at the time, that the Sawyers had or would deceive you, in regard to the life of these carbons, or to suspect that the carbons had been changed in lamps, which you were led to suppose had not been touched?

A. No.

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1812 x-Q. You were not looking for deception on their part?

A. No, but I was looking to see that I was not deceiving myself. I do not remember ever asking them in regard to the changing of the carbon, for I observed the changes myself, and I was observing the carbons in the lamps, and the lamps, and how they were affected by use; watching them continually while I was there and they were running, or examining them if they were not running.

1813 x-Q. Your habit was to run these lamps until 3082
they gave out?

A. Yes, until the carbon gave out, or something happened to the lamps or until seeing, as we thought, a change for improvement in the lamp, we took it down, made the supposed improvement and set it up again, sometimes with the same carbon, sometimes with a different one.

1814 x-Q. Did you try running different carbons under the same conditions, to ascertain their respective life? 3083

A. Yes, as nearly as we could.

1815 x-Q. I understand that the conclusion of your experiments in March, 1879, or rather prior to that time, while you were still at 94 Walker street, the Electro-Dynamic Light Co., considered your lamps so far perfected as to order several hundred to be made. Is that the fact, and that a great many lamps were made in conformity to such order?

A. Yes.

1816 x-Q. About how many lamps were made in 3084
conformity to that order?

A. I do not know that I ever knew how many.

1817 x-Q. At this time had you decided on a type of lamp as being the one that you intended to introduce?

A. We had decided upon several which we thought were suitable for introduction.

3085 1818 x-Q. Any one that you preferred?

A. There were two forms which we preferred; possibly three; one was a straight pencil carbon; the other was the loop or arch form carbon; another was a carbon held straight across the tops of the holders with adjustable tension between the holders.

1819 x-Q. Now, these lamps that were made by you in conformity with the large order of the company—what kind of carbons did they have, and what was their form?

3086 A. The carbons were straight pencils or strips of pure deposit carbon, some hollow and some solid arched carbons of pure deposit carbon; some of the same of both shapes with a core of wood or other fibrous carbon inside; some of both shapes of wood or other fibrous carbon treated according to our electrical process to all extents, from a treatment barely sufficient to drive out occluded gases, purify the carbon, render its resistance uniform throughout its length and regu-
3087 late the resistance to conform to other carbons of the same kind, up to a treatment making a substantial deposit appreciable thickness upon the fibrous core; some of these carbons of both shapes were substantially round in their cross section, some of them were flat and thin and some of them were square, or nearly so, in cross section.

1820 x-Q. This order was the first commercial order that was given for Sawyer-Man lamps, and the lamps to which you have referred were made in response to it?

3088 A. I think so; that is, it was the first direction given by the company to make lamps for commercial use.

1821 x-Q. How did it happen that there was such a variety and difference in the shape and substance and treatment of the carbon and such difference in the construction of the lamps as must have been necessitated thereby?

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A. I do not think that there was anything strange about it when it is considered that the superintendent of the work was an inventor and desired to make the lamps in a variety of forms rather than one.

1822 x-Q. What do you mean, that it was left to you and Sawyer to make such lamps only as you saw fit, the number only being ordered?

A. I mean just what I say; that these different forms of lamp having been made before that time or project-
ed and the different forms and characters of carbon 3090
having been tried; the order of the company was given to make the lamps, and the character of the lamps to be made was not specified; I will add that there was another reason for this, I mean the not settling down to one particular form of lamp and carbon a thing that I personally greatly desired to accomplish.

1823 x-Q. Then the order of the company left it to you and Sawyer to decide upon the kind of lamp that should be made and the shape and character of the
carbon to be used? 3091

A. Yes.

1824 x-Q. Why then did you make lamps containing the differences you have mentioned?

A. I suppose to try upon a large scale which was the best.

1825 x-Q. You say "suppose," don't you know?

A. I know that that was all the reason I had for doing so, or consenting to its being done.

1826 x-Q. Then at this late day, you had not deter-
mined which was the best form for the carbon or the 3092
best material?

A. Yes, I think I had.

1827 x-Q. You say you "think," don't you know?

A. Yes, I believe I had.

Adjourned till Tuesday, the 13th inst., at 10½ A. M.

3093

New York, Dec. 13, 1887.

Met. Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows:

1828 x-Q. If you were satisfied at this time of the superiority of one kind of carbon over the others, what is your explanation of making lamps of those carbons that you knew to be inferior, the lamps having been intended, as you say, for commercial use?

3094 Objected to as immaterial and not cross-examination.

A. Prior to the giving of the order or direction by the company for making a large number of lamps for commercial purposes we had made a number of lamps of each of the kinds of carbons that I have described, all of which were good and satisfactory lamps; I had my own ideas and preferences in regard to the carbons in these different lamps; I endeavored to have them
3095 carried out after these orders were given; my own time was greatly absorbed by my business in charge of trust estates and property, where I was handling hundreds of thousands of dollars and had charge of millions of dollars' worth of property, real and personal; and I was worn out with the work of that and in the workshops of the Electric Dynamic Light Company, so that I could not give as much attention to the work there as I had previously done; and in December, 1878, was obliged to substantially give up work in the
3096 shop and get through the Company Mr. Lawrence Myers to go to the shop and stay there continuously, and try to keep Mr. Sawyer sober; Mr. Sawyer's habits of inebriation grew on him to such an extent as to seriously interfere with his duties and work as superintendent of the work of the company; I did not succeed in having my ideas carried out, and Mr. Sawyer's condition was such that systematic and continued work upon

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what, previous to that time, had been considered the best carbons was not uniformly continued by him; it was due, as I think, to Mr. Sawyer's habits and the result of those habits in bad workmanship and carelessness in work where the utmost particularity and care was required, as it is to-day, in the manufacture of incandescent lamps, that the work was not as systematic as it should have been and as I desired it to be, and that the best or what we considered the best, carbons were not made and put into use more extensively in 3098
the lamps we built.

Answer objected to as irresponsive and as containing many matters that are immaterial, as to which the testimony is incompetent and others in respect to which he has not been interrogated.

1829 x-Q. I want you to tell me how it happened that in filling this large order for lamps intended 3099
to be used commercially, carbons of different material were used, some of which you believed to be inferior to others?

Objected to as having been already answered.

A. I have already fully answered that question, that it was due to Mr. Sawyer's being drunk, neglecting his work and making bad work, &c., being capricious, unmanageable and incompetent to exercise good judg- 3100
ment, and to my inability to be present at the workshop, as I had been before.

1830 x-Q. What had these facts to do with making the carbons of different material? I can understand how his intoxication could have interfered with his workmanship or prevented the work from being of the best kind; but how does it account for the making of the carbons of these lamps intended for commercial

3101 purposes of such different materials which I should suppose would require a greater amount of work than if they were all made of one?

A. Mr. Sawyer was the superintendent; he gave directions to the work; his bad workmanship and judgment when drunk and his carelessness while in that condition, resulted in the failure of many lamps, obscured what had previously been well settled and ascertained in our joint judgment, and led him to make first one thing and then another to remedy the defects which caused his failures, and so it was that he con-
3102 tinued to put all kinds of carbons that we had made in the lamps, first one and then the other, and I was not there, and could not be, to control, if I could have done it, if I had been there.

1831 x-Q. You did not then participate in the making of these lamps?

A. Yes, to some extent; but not to a great extent, or as great an extent as I had before.

1832 x-Q. You did not approve of the use of these different carbons in the lamp, then?
3103
A. Yes; sometimes I did and sometimes I did not.

1833 x-Q. You understand I am speaking of the filling of this order?

A. Yes; it would be more proper to say that I acquiesced in it, because I could not help it.

1834 x-Q. You were cognizant, then, of how the order was filled as it progressed?

A. Yes, I think I was as fully as I was able to keep myself informed, but I could not keep myself fully informed of the work that was going on in all its stages.
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1835 x-Q. You say that sometimes you approved of putting different carbons in these lamps and sometimes not; please explain what you mean?

A. I mean that we had made good lamps with all these carbons, and that when Mr. Sawyer told me of his failures of some of the lamps made with any of the kind of carbons, or I observed those failures myself,

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and Sawyer told me that he was making lamps with different carbons, and believed that he would not make so many failures with the other kinds of carbon; I acquiesced in his going on with it, sometimes, and sometimes I protested, and tried to keep the work uniform.

1836 x-Q. What fact or circumstance would influence you in acquiescing or protesting?

A. I don't recollect what particular facts or circumstances did at any particular time or instance; I only 3106
recollect that I was anxious to get a large number of lamps that were good and satisfactory, completed—more desirous of this than of testing or exploiting any particular carbon in the lamps.

1837 x-Q. So you practically let Mr. Sawyer go ahead as he saw fit?

A. Yes, if he would make good lamps.

1838 x-Q. Leaving to him to determine how good lamps should be made?

A. No, we had made good lamps in large numbers 3107
before, and the patterns were before him and in use.

1839 x-Q. But the fact is he went ahead, making lamps having carbons of different shapes and different materials, some of which were better than others?

A. Yes, I thought so.

1840 x-Q. But you allowed him to go ahead and make the inferior carbons and shapes as well as the superior?

A. So long as he would make good lamps we urged him to do it, irrespective of the kinds of carbons or 3108
their shapes.

1841 x-Q. Now, had Sawyer, at this time, a decided preference for one shape or kind of carbon?

A. I don't know; I don't think he was capable during a great part of the time of exercising intelligent judgment in the matter.

1842 x-Q. What I want to know is whether he had formed a judgment?

3109 A. He had before this time formed a judgment, and
expressed it to me.
1843 x-Q? Is it your belief that at this time he had
a preference.
A. I don't know.
1844 x-Q. Do you mean to say that at a time when
you claimed the experimental stage of your work was
over, that you were ready to manufacture lamps for
commercial use, and an order had been given by the
company for the manufacture of a large number of the
3110 lamps, and you and Sawyer were manufacturing them,
that you don't know whether your co-worker and co-
inventor had a preference for one kind or shape of
carbon over another kind or shape?
A. I mean to say that at this time, while the manu-
facture of these lamps was going on, that had been
directed to be made by the company, that my co-
worker, Mr. Sawyer, was not usually or ordinarily in a
condition to exercise intelligent judgment upon the
matter, and that he expressed himself in such various
3111 and contradictory ways to me—one thing to-day and
another to-morrow—that I could form no opinion as
to his having preference one way or the other, except
temporary, and not reasonable and permanent.
1845 x-Q. If such were his conditions, why did you
entrust the manufacture of these lamps to him?
A. We could not help ourselves; no one else except
I was educated in the work; he made many good
lamps, and we wanted to get lamps made, as I have
stated before.
3112 1846 x-Q. Then, is this the fact, that Sawyer was
not so drunk or so unintelligent that he was not capa-
ble of making or superintending the making of good
lamps—lamps which you intended to sell and use
commercially; but that he was so drunk and so unin-
telligent as to be incapable of selecting the best kinds
and shapes of carbons, that having been a matter upon
which you and he had already decided?

A. If I permit you to testify for me, I should convey 3113
very curious ideas, it seems to me; I have stated that
Mr. Sawyer's inebriate habits interferred with his work
in the making of the lamps, and caused him to make
failures in their making; that while he made good
lamps he also made bad ones; that his failures ob-
scured in his mind what we thought had been previ-
ously made clear; the perference for carbons which we
had been agreed upon in opinion; that his mind was
rendered vacillating; as any drunken man's is; that I
could form no intelligent opinion in regard to his then 3114
preference, by reason of such vacillating.
1847 x-Q. If you could have had your way, would
the lamps all have had one shape and one character of
carbon?
A. Yes; unless that shape and that character had
proved unsuccessful in use.
1848 x-Q. Had your experiments reached such a
point that you had a decided preference for one shape
and material?
A. Yes; one general shape, and of one material 3115
treated.
1849 x-Q. And if you could have had your way
these lamps would have all been of that shape and
material?
A. Yes, if the first had proved successful lamps.
1850 x-Q. What do you mean by saying "if the first
had proved successful lamps?" Was not your mind
sufficiently made up at that time?
A. My mind was made up. I mean by "first" the
first lamps set up and run of those made under that 3116
order.
1851 x-Q. Was it sufficiently made up to have made
all the lamps after one model, and having one kind and
shape of carbon?
A. It was.
1852 x-Q. But yet, if the first instalment of lamps
made up under this order had not been good, would

3117 you have changed the shape and material of the carbon?

A. Yes, one or both unless the failure should have been due to some cause outside of the carbon. If we had deemed the failure due to the shape or material of the carbon, the shape or material would have been changed.

1853 x-Q. Had you then learned so little from all your experiments, that you would at this time, have changed the shape and material of the carbon, if the
3118 first instalment of lamps had been a failure which you attributed to the shape of material?

A. I will answer this by saying that I had no fear of failure by reason of the shape or material of the carbon, but that at any time we would have adopted a better shape and a better material which we could control as would be done to-day in incandescent electric lamps.

1854 x-Q. Then you do not think it possible that you could have attributed any failure in the first in-
3119 stalment of lamps to the shape or the material of the carbon, if they had been made of the shape and material you preferred?

A. I do not think it probable that I would have attributed the failure of the first lamps to the shape or material of the carbons if they had been properly prepared and made.

1855 x-Q. What shape and material did you prefer?

A. I preferred a carbon of fibrous material electrically treated, of a form rising above the holders, of an
3120 arch or loop-shape.

1856 x-Q. What kind of fibrous material?

A. I think paper fibre or paper carbon were my preference at this time, next wood carbon of willow.

1857 x-Q. What kind of paper?

A. Paper that was pure and had not remaining in it anything but cellulose.

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1858 x-Q. Please mention the name of such paper?

A. The nearest paper of that kind in ordinary use is white blotting paper, or paper similar to it, unsized paper, of clean, pure paper stock.

1859 x-Q. You say you preferred fibrous material treated to what extent?

A. Treated, as I have stated, to the point where the resistance of the carbon throughout its length would be rendered uniform, and to the point where there
would not be so much of the deposit carbon on it as 3122
to render it liable to fly to pieces, as pure carbon does, when suddenly heated up. This treatment in our practice simply gave the carbon a silvery or lustrous appearance, and did not apparently change its dimensions.

1860 x-Q. Some two hundred lamps were made pursuant to this order, were there not?

A. I should think so; perhaps not so many.

1861 x-Q. How many of such lamps had loop or
arch-shaped carbons? 3123

A. Few, comparatively; perhaps fifty; that is my best judgment.

1862 x-Q. The others were straight carbons?

A. Yes.

1863 x-Q. How many of these two hundred lamps had conductors of fibrous material?

A. I don't know.

1864 x-Q. What is your best recollection?

A. At this date I should simply have to guess. I
should think from a third to a half; perhaps not so 3124
many. They were not near so many as those having mineral carbons or deposit carbons.

1865 x-Q. Who made the carbons for these lamps?

A. Mr. Edward Myers did the carbonizing, mostly. Mr. Sawyer did the treating.

1866 x-Q. Edward Myers is dead, is he not?

A. He is.

3125 1867 x-Q. Where was the carbonizing done?

A. In the furnace of the steam engine at 94 Walker street; our own furnace, in our own room.

1868 x-Q. Who did the mechanical work on these two hundred lamps.

A. It was done all over town, in different places.

1869 x-Q. Tell me the places.

A. That I don't know; the metal spinning was done at three or four places in Centre street; the glass work
3126 was done at the factory in Brooklyn near South 7th Street Ferry; the carbon work, other than the incandescent carbons, was done at two or three different places; the soapstone discs were done by a soapstone man down in the vicinity of Water street and, I think, Peck Slip; in that neighborhood; the metal work was, part of it, done by H. L. Judd & Co., in Brooklyn; part of it was done by different mechanics in Centre street; one was a firm, I do not recollect their names, in the top story of the building at the corner of Howard and
3127 Centre streets; the setting up was done at our shop, 94 Walker street.

1870 x-Q. What persons or mechanics assisted in the assembling of these lamps at 94 Walker street?

A. Mr. Wm. Sawyer, who is now dead; Mr. George Sawyer, Mr. Wm. Sharp, Mr. Edward Myers and Mr. Wm. E. Sawyer.

1871 x-Q. The only persons living are Geo. Sawyer and Mr. Sharp?

A. I think so.

3128 1872 x-Q. They ought to know, then, the mechanical character of these lamps, and whether they had straight or circular carbons?

A. I don't know whether they would or not.

1873 x-Q. If they put the work together they ought to?

A. I don't think they ever put the carbons in the lamps.

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1874 x-Q. Could they not tell from the holders whether the carbons were to be upright and straight or horizontal or curved?

A. They could tell whether the carbons were to be set upright or horizontal, not whether they were to be curved or straight.

1875 x-Q. Were the various parts of these lamps made from drawings or models?

A. I think they were made from drawings and samples both. 3130

1876 x-Q. Did you give any of the instructions to the mechanics, or furnish them with the drawings or samples?

A. Yes, I think so, but it was mostly done by Mr. Sawyer.

1877 x-Q. Give me the names of any persons whom you thus gave information to or instructed?

A. H. L. Judd & Co., the glass men in Brooklyn, I don't know their names, and the soapstone man whose name I do not remember; I probably gave directions 3131
to others, but I do not at present recollect their names. I remember one, one other to whom I gave instructions and models for castings in brass, but I don't remember his name; his location was a brass foundry near the Five Points, New York; I remember also being at two or three metal spinners with reference to the work; I do not remember their names.

1878 x-Q. What kind of fibrous material was it that was used in these lamps?

A. Mainly paper and wood. 3132

1879 x-Q. To what extent was it treated?

A. Some of them were treated with a view of the removal of the fibrous carbon to leave pure deposit carbon for the incandescent conductor of the lamp, some of them were treated so as to make a visible coating of appreciable thickness upon the conductors; most of them were treated to the extent I have specified or

3133 approximating that as in accordance with my preference as stated to-day.

1880 x-Q. What was the extent of that treatment; I mean, was it sufficient to fill up the pores of the material and coat it.

A. No, it left the material still porous, its ultimate fibers were, of course, coated, but the coating was infinitely thin except where points of higher resistance were regulated in the process to make the conductor uniform in resistance throughout its length.

3134 1881 x-Q. How many of these two hundred lamps had conductors of carbonized paper or wood treated to this slight extent?

A. That I do not recollect.

1882 x-Q. About how many?

A. I did not do the work and I do not know.

1883 x-Q. Have you no idea?

A. No, not to express it in numbers; I can guess, I should think more than half of the fibrous carbons were treated, or intended to be, in that way.

3135 1884 x-Q. What is your best recollection as to how many of these two hundred lamps had fibrous carbons treated to this slight extent?

A. I have no recollection which would enable me to fix the number; I can guess.

1885 x-Q. Well, guess, if that is the best you can do.

A. I should think thirty or forty lamps, maybe more rather more than less.

1886 x-Q. I understand that some of the straight carbons were fibrous and some not, and some of the
3136 loop-shaped carbons were fibrous and some not?

A. Yes.

1887 x-Q. Who now living knew that some of these two hundred lamps contained these fibrous carbons treated to this slight extent?

A. I think that Mr. George Sawyer and Mr. Lawrence Myers knew of it at the time, and that the other

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gentlemen, the two Messrs. Hays and Mr. Classen were told of it; I think Mr. Amos Broadnax knew of it, and I knew of it; how much the others can recollect of it at this time I do not know.

1888 x-Q. What has become of these two hundred lamps?

A. Part of them I have, one or two; a part of them Mr. Sawyer took when we left Walker street; part of them were put up, packed in barrels, and left with me at the time when we left 94 Walker street; part of 3138
them Mr. Sawyer subsequently got from me for making exhibitions and never returned; part of them were used in our workshop in lighting them, the shops, up; part of these were used up in running them in exhibitions, experiments and testings at our place, 94 Walker street; part of them were taken down and modified by Mr. Sawyer.

1889 x-Q. Do you know whether there is now in existence one or more of these lamps containing a fibrous carbon conductor treated to this slight extent? 3139

A. I do not; I think there is.

1890 x-Q. Where?

A. I don't know where.

1891 x-Q. Were these two hundred lamps paid for by the Electro Dynamic Light Co.?

A. They were, all the work.

1892 x-Q. Are there no books or papers in existence that would show who was paid for the work and who did it?

A. There were books and papers and bills which 3140
would show who was paid for part of it, not all.

1893 x-Q. Where are they, and in whose possession?

A. I don't know; the last I saw of them they were in the possession of the company.

1894 x-Q. What person had the custody of them?

A. I think the last time I saw them they were in the custody of Mr. Lawrence Myers or Mr. Jacob Hays.

3141 1895 x-Q. Were these two hundred lamps delivered to the company, and were they its property?

A. They were in the company's shops and were its property; there was no formal delivery of them.

1896 x-Q. Why did you in no way in the interference case mention or refer to this large number of lamps which you now say were made, and which had conductors of fibrous material and were made for commercial use?

A. I don't know whether I did or did not so refer to
3142 them?

1897 x-Q. The fact would have been important, would it not?

A. I do not know; it is proper to say that I have not stated here that these lamps were put to any use, except that of the company, or use made of them by Mr. Sawyer after March, 1879. This reminds me that I think some of these lamps were taken by Mr. Sawyer to Ansonia, Conn., to Mr. Wallace's place; I don't know whether those taken there had fibrous carbons in
3143 them or not.

1898 x-Q. Why was not one of these lamps containing fibrous carbons put in evidence in that interference?

A. That I don't know.

1899 x-Q. Why were not the people whom you say knew of them interrogated concerning them in that interference?

A. I really cannot tell why anything was not done.

3144 Mr. Broadnax, of counsel for complainant, says, that "you" (witness) might say that there was enough before the Commissioner to satisfy him (Commissioner) that Sawyer and Man were the first inventors, and that that is a good reason why there was nothing more put in.

3145

1900 x-Q. These two hundred lamps having been made for commercial purposes, what generator of electricity did you intend to use with them?

A. We intended, when we should introduce the lamps into uses other than our own, to have dynamos built to run them.

1901 x-Q. These two hundred lamps, under what conditions of current and electro-motive force were they constructed to be used?

A. I do not know, for they were of very variable resistance. 3146

1902 x-Q. Were they not approximately of one resistance?

A. No.

1903 x-Q. Were they not adapted for use approximately under the same conditions?

A. Not in the same numbers, nor in the same arrangements.

1904 x-Q. Were they intended to be run in series?

A. Yes, some of them, a series of from eight to twelve lamps. 3147

1905 x-Q. Were they not constructed in reference to some definite system or arrangement?

A. No, they were not, except in the limited numbers of from four to twelve, and some of them for use as single lamps.

1906 x-Q. Between what limits did the resistance of these two hundred lamps vary?

A. That I cannot tell in regard to any of our lamps; I know that some of them were less than an ohm and some of them, I think, were from thirty to fifty ohms, 3148
and perhaps higher.

1907 x-Q. Why was there so great variance in the resistance of these two hundred lamps?

A. It was an eminent illustration (these lamps, two hundred, more or less) of the want of systematic work due to the condition of Mr. Sawyer, as I judged at the time, and of his inability by reason of inebriation to

3149 discriminate and judge and plan and adopt and adhere to system and regularity, and of the combination by Mr. Sawyer of work more in the character of experiments than for one particular purpose and in one particular plan.

1908 x-Q. Was this wide difference in resistance due to accident or design?

A. I think it was due to design.

1909 x-Q. Your design?

A. No, design on Mr. Sawyer's part.

3150 1910 x-Q. Had *you* any desire or preference as to what the resistance of these lamps should approximately be?

A. I will answer that question by saying that I have never determined in my own mind what the most advantageous resistance in an incandescent electric lamp is or should be.

1911 x-Q. Please answer my question by telling me whether *you* had any desire or preference as to what the resistance of these two hundred lamps should be?

3151 A. Not any fixed resistance, that is, I had determined no such resistance in my mind.

1912 x-Q. Had you any preference or wish as to what *about* the resistance should be?

A. I have answered that question as fully as I can.

1913 x-Q. Do you mean that you were indifferent as to whether they were a tenth of an ohm or a hundred ohms.

A. No, I do not mean that.

1914 x-Q. Were you indifferent as to what their
3152 resistance should be?

A. No, I wanted them of suitable resistances.

1915 x-Q. What did you then consider suitable resistances?

A. Very various, as I do to-day.

1916 x-Q. Did you want these lamps then to vary in resistance?

3153

A. Yes, a little.

1917 x-Q. Did you then think Sawyer had done well in making them of different resistances?

A. No, not as they were made.

1918 x-Q. Do you mean that you approved of the variance in resistance, but did not approve of the means by which it was obtained?

A. No, I do not mean generally.

1919 x-Q. What was the resistance of the great majority of these lamps, about? 3154

A. I do not know; I should judge from one to five ohms.

1920 x-Q. Had Sawyer any opinion at this time as to what, about, was the most desirable resistance in an incandescent lamp?

A. I do not know or recollect.

1921 x-Q. Had Sawyer and Man, as joint inventors?

A. At that time when these lamps were built I do not think that we had or agreed upon anything as a 3155
fixed desirable resistance.

1922 x-Q. Had you agreed upon anything approximately?

A. At this time I do not think we consulted together in regard to it.

1923 x-Q. Now these lamps, you say, were made for commercial use; that being so, had you no idea of the character of the dynamo they were to be used in connection with?

A. Excuse me; I did not say they were made for 3156
commercial use; I said they were ordered to be made with the intent to have them used commercially. The lamps which we did make could all of them be run with the dynamos and other appliances we had.

1924 x-Q. Were the lamps made for commercial use or were they not?

A. We made them with a view of having lamps for commercial use. They were, many of them, lamps

3157 suitable to be used commercially in various positions and in various arrangements.

1925 x-Q. You did not make them, then, with reference to any approximate condition of current or electro-motive force?

A. We made them for use with various currents and various electro-motive force, as I have stated.

1926 x-Q. Were any of these lamps ever sold for use commercially?

3158 A. I don't know of any unless it was the lamps that were taken to Ansonia. I think they were paid for by Wallace.

1927 x-Q. What do you mean by saying they were paid for by Wallace; that he took them as part of your experimental plant?

A. No, Mr. Wallace did not take our experimental plant, except a dynamo, as I recollect. That belonged to me and I lent it to him.

1928 x-Q. Did the Electro-Dynamic Light Co. ever
3159 order any lamps to be manufactured other than these two hundred, and subsequent thereto?

A. My recollection in regard to that matter is that two or three directions were given by the board for the manufacture of specific lamps. They were, some of them, I think, made and set up, but they would be included in my estimate or guess of two hundred lamps made.

1929 x-Q. With the exception, then, of this lot of two hundred lamps, more or less, of which we have
3160 been speaking, your recollection is that no other lamps were made than the few specific lamps referred to in your last answer?

A. No, that is not my recollection. The few specific lamps are included in my estimate of two hundred lamps made after the first direction given by the company. Before any specific direction was given by the company we had made, as I stated before, a considerable number of lamps of all the different varieties I stated.

This is not included in my estimate of the number of lamps made after the direction of the company to make a specified number. 3161

1930 x-Q. Did the making of these two hundred lamps, more or less, in the pursuance of the order of the company, practically complete the work of Sawyer and Man?

A. Yes, practically, the making of the lamps which I have estimated at about two hundred, after the direction of the company to go on with the manufacturing 3162
practically, completed the work of Sawyer and Man together.

Adjourned till Wednesday, the 14th inst., at 10½ A. M.

NEW YORK, Dec. 14th, 1887.

Met pursuant to adjournment. Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows: 3163

1931 x-Q. In your 1887th answer, you say that you have one or two of these lamps made in Walker street pursuant to the order of the company; will you produce them at the next sitting?

A. I will, if so instructed. I am unwilling to give these lamps out of my custody. I had a complete assortment of all the lamps including all the different 3164
shapes of carbons and different kinds of carbons including fibrous carbons of different kinds, and they have got them all away from me except these, among others one that I had set up with my own hands at 43 Centre street and which was used as an exhibit in some of the cases and they are all used up, broken and lost so far as I know; and I do not propose to give up the last remnants which I have of my work.

3165 1932 x-Q. Will you bring such lamps as you have with you at the next sitting?

A. Yes, if so instructed.

1933 x-Q. You went to 94 Walker street the last of September, 1878, and remained till the latter part of March, 1879?

A. Yes.

1934 x-Q. And experiments were conducted there during that time?

A. Yes.

3166 1935 x-Q. Was any carbonizing done there?

A. Yes.

1936 x-Q. While at 94 Walker street did you carbonize any at your house?

A. I do not remember; it is probable that I did, but the bulk of what was dône was done at the shop.

1937 x-Q. Who did it usually?

A. I did some, Mr. Edward Myers did—the most of it, I think Mr. Sawyer did some.

1938 x-Q. Who now living knew of its being done
3167 there?

A. I think all that I have mentioned as being at the shop, including our workmen and Mr. Church, Mr. George Sawyer, Mr. Sharp, Mr. Lawrence Myers, Mr. Amos Broadnax and myself, and Mr. Wm. H. Church. There are probably a large number of other persons that saw it, but I don't know.

1939 x-Q. Who assisted in the work at 94 Walker street?

A. Mr. William E. Sawyer, George Sawyer, George
3168 W. Sawyer, Sharp and men who were employed by the day, but who they were I don't remember.

1940 x-Q. So far as experiments on the lamps were concerned at 94 Walker street, what direction did these experiments take?

A. Before going to 94 Walker street we had ordered and got delivered in part glass globes and bases

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of different sizes and shapes, and the leading-in conductors with their apparatus, spun caps for covering the base of the lamps of different sizes, the convoluted or folded conductors beneath the diaphragm, their connection through the base of the lamp, diaphragms, screws and carbons, and an assortment of a metal of different sizes and shapes for making holders and parts above the diaphragms of the lamps; we had given orders for the making of a dynamo, and generally had prepared more thoroughly
than before for the commencement of work on our 3170
lamps, switches, &c., bought and prepared electrical apparatus, resistance and measuring instruments; our first work was directed to the manufacture of the several different kinds of lamps I have mentioned as manufactured or made before the direction given by the company to proceed with the manufacture of a large number of lamps, in order to get good lamps, improve their shape and appearance, and settle down
upon all the different parts of lamps for different uses 3171
and of different kinds; to the preparation and testing of different kinds of carbon and their adaptability for use in different lamps as incandescent conductors; meantime the testing and trial of different dynamos went on and testing and trial of different methods of treatment and different extent of treatment of the incandescent carbon conductors; at the same time we were preparing switches, regulators, and resistances and automatic cut-outs, and doing the electrical experi-
ments and work of testing and measuring; after we had 3172
got a sufficient number of lamps ready they were exhibited to the officers of the company—the directors, stockholders and their friends; matters having progressed so far, the direction of which I have spoken was given by the company to proceed to the manufacture of a large number of lamps, and the work of making and setting up lamps and the other work I have spoken of was continued; the materials for the large

3173 number of lamps I have spoken of as directed to be made were contracted for and procured in whole or in part from a great number of different people. I have omitted to mention the very extensive work which was carried on with reference to the atmosphere of the lamps, commenced at 43 Centre street, carried on more extensively during the last days of August and in September, until we went to 94 Walker street, while we were at the corner of Howard and Centre streets; this work involved extensive chemical apparatus and
3174 materials and means of exhausting the chamber of the lamp and was carried on in part in our own shops, in part at Stevens Institute, Hoboken, in part at the School of Mines in New York, and in part at a place in Broadway, down near the Battery; this is a general description of the work up to the time in November or December, 1878, when I was obliged to give up working so much and giving so much of my time to the work of the company; after this time much the same kind of work was continued under the superintendence of Mr.
3175 Sawyer, with my attention only so far as I was able to give it from time to time up to the time in March when we left 94 Walker street.

1941 x-Q. From whom were the globes, bases, leading-in conductors with their apparatus, spun caps, the convoluted or folding conductors, the diaphragms, screws and carbons mentioned in your last answer ordered and obtained?

A. I have already answered that question as completely and fully as I can.

3176 1942 x-Q. You only remember the name of Judd & Co?

A. Yes, none other occurs to me now.

1943 x-Q. To whom was the order for a dynamo given referred to in your last answer?

A. Arnoux & Hochausen.

1944 x-Q. Was the machine made?

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A. Yes, but not before we got to 94 Walker street.

1945 x-Q. Was this the machine you principally used at 94 Walker street?

A. Yes, I think so; I do not know but that another was substituted for it of a similar kind.

1946 x-Q. What has become of this machine?

A. I think it is at Mr. Wallace's place at Ansonia, Conn.; I lent it to him.

1947 x-Q. Can you tell me approximately its capacity or construction? 3178

A. No.

1948 x-Q. Was the machine a special design, or one of Hochausen's regular make?

A. In general appearance it resembled the arc lighting machine which they were then building.

1949 x-Q. How did it compare with them in capacity—do you remember?

A. I object to further use of my time in repeating testimony already given; only that it was of less electromotive force. 3179

1950 x-Q. You say, in your answer to the 1939th question:

> "After we had got a sufficient number of lamps ready, they were exhibited to the officers of the company, the directors, stockholders and their friends."

Did any of these lamps contain fibrous carbons but slightly treated, either straight or in the loop form?

A. Yes, some of those we exhibited contained the 3180 fibrous carbons treated in a slight way.

1951 x-Q. Were the persons to whom they were exhibited told the nature of the carbons?

A. I think the officers and directors of the company were told in regard to it, but I do not know.

1952 x-Q. Mention such persons as are now living that you think were told?

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A. I think the two Messrs. Hayes, and Mr. Myers,
and Mr. Church; I know Mr. Broadnax was told in regard to it, and that it was exhibited to him, and that he was applied to early in October by me to apply for patents for the fibrous carbons?

1953 x-Q. What was the material of the conductor of the great majority of the lamps made at Walker street?

A. Either mineral carbon or deposit carbon, as I have said a great many times.

3182 1954 x-Q Had the majority of lamps made there
straight or circular carbons?

A. Straight.

1955 x-Q. Were the lamps with straight carbons substantially such as shown in your patents?

A. In general appearance the same: they did not
have the support G, shown in the first patent: they
more nearly resembled the figure 8, shown in that patent, and were more like the lamps shown in patent
210,809, except that some of them had straight carbons
3183 extending horizontally across between the holders;
these last were of the same general construction of the
lamps with looped or arched carbons, the only difference being compensation for expansion and contraction
of the incandescent carbons.

1956 x-Q. About how many lamps in all should you say were made at 94 Walker street?

A. I have already stated that I do not know the
number, and can only guess at it; but I should judge
somewhere between two and three hundred—about two
3184 hundred and fifty or sixty would be the minimum idea
in my mind of the number, and it may have been very
much more than three hundred.

1957 x-Q. What is your explanation of the fact that the majority of the lamps made in Walker street had straight carbons, if, as I understand the fact to be, you had made lamps with circular carbons, which was a better and cheaper construction?

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A. There are several things which occur to me in this connection; one was that we had not applied or got the application made for the fibrous carbons and the loop shape, which we then considered belonged to us, and were in doubt, under the advice given by counsel, whether the invention was patentable; another was that, after we commenced the manufacture of lamps, Mr. Sawyer's condition was such, from inebriation, that he was not capable of exercising good judg-
ment in regard to the matter, and Mr. Sawyer was the 3186
superintendent in charge of the work.

1958 x-Q. What is your explanation of the fact that the majority of lamps made at Walker street had conductors made of hard or deposited carbon, if it be true, as I understand you to say, that fibrous carbon was the better carbon and the easier to make?

A. Before going on to the making of our largest
number of lamps, as I have stated, I think Mr. Sawyer
and I were agreed in opinion as to the fibrous carbon
and the loop form being the preferable one; when the 3187
larger number of lamps were being set up by Mr. Sawyer and tested, he set up a considerable number of lamps of this form with this carbon and tested them, and many of them failed, perhaps a majority, through, as I believe, no defect in the carbons or their shape, but to unskillful manipulation in the setting up of the lamps. He was not in a condition to exercise good judgment in regard to them, and discriminate in
regard to the causes of his failures. This rendered
him vacillating and changing. He then went on to set 3188
up lamps with straight carbons with much the same result. He changed the forms and interior works of the lamps from what we had settled upon. I think, as a whole, he preferred the straight carbon lamps at that time, and built them mostly, although not entirely, and I think that he preferred on the whole the deposit carbons for conductors, and used them mostly, but not

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entirely. I could not give directions to the work nor have it carried on, nor control it as I wanted to. As I said, Mr. Sawyer's opinion was one thing to-day and another to-morrow. I was, as I have said before, and the company was, more anxious to get good lamps built in large numbers, than to work out and determine the absolutely best form of lamps, and in order to do so we let Mr. Sawyer do as he pleased in a large measure. And to this answer I desire to add as a
3190 reason, the whole of my last previous answer.

1959 x-Q. An arrangement has been referred to that was made with Wallace of Ansonia; will you please state what that arrangement was and what was done in regard to it?

A. In the spring of 1879, the Electro Dynamic Light Co. granted an exclusive license to the Wallaces of Ansonia, for the manufacture and sale of all our patented appliances and inventions up to that time, coupled with an agreement on the part of Mr. Sawyer
3191 to go to Ansonia and instruct the workmen and superintend the building of lamps and other apparatus, and putting them in operation, for which Mr. Sawyer received payment from the company or its stockholders, and Mr. Thomas Wallace became president of the Electro Dynamic Light Co., and Mr. Edward Myers, who had been in the employ of the company up to that time, from, I think, early in September, 1878, was employed by the Messrs. Wallace to assist in the work. The Wallaces were to pay royalty to the
3192 company for every lamp put out, and to build and put out a large number of the lamps. The Wallaces went on and commenced to work, and got ready the parts for a large number of the lamps, but Mr. Sawyer's conduct was such, and his habits so bad, as I understand from him and Mr. Wallace, that they could not get along with him, and finally turned him out, and went on with the work with Mr. Myers in charge. Mr.

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Myers was taken sick some time in the fall of 1879, lingered along, expecting to return to the work which was held in waiting for him, and finally died without returning, at his father's house in Plattsburgh, New York. There was no person educated to the work and who could go on with it as Messrs. Wallace claimed, whom they could get. The matter lingered along and no work was done by or under the Electro-Dynamic Light Co., until finally a consolidation was made with
the Eastern Electric Manufacturing Co. and the 3194
patents and inventions were assigned to that company and the Messrs. Wallace surrendered their license.

Adjourned till Thursday, the 15th inst., at 1 P. M.

Thursday, December 15, 1887.

Met pursuant to adjournment. 3195

Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows:

1960 x-Q. Did Wallace ever make any lamps?

A. I don't know whether he ever completed any or not; I was not there.

1961 x-Q. What was the general model of lamps that was to be made by Wallace?

A. I don't know; I suppose all the different kinds.

1962 x-Q. What carbons were they to have? 3196

A. I do not know; all the different kinds of carbons that the Electro-Dynamic Light Co. owned, I suppose.

1963 x-Q. Of what shape were the carbons to be?

A. I don't know.

1964 x-Q. Who was to decide on all these matters?

A. The Messrs. Wallace.

1965 x-Q. Did the Wallaces know the preferences

3197 of the inventors, and what constructions they considered best?

A. I think Mr. Thomas Wallace knew what had been done. I am not certain of that. The lamps were exhibited to him and his representatives by Mr. Sawyer, at 94 Walker street. I was not present and don't know what Mr. Sawyer told him. I remember before the arrangement was completed of only one conversation with Mr. Wallace. I do not remember expressing any preference to him in regard to the carbons or their
3198 material. I do not remember having expressed a preference for the incandescent lamps, over the semi-incandescent or feeder lamps.

1966 x-Q. Did you ever inform the Wallaces, or did the company ever inform them, as far as you know, that you preferred a conductor of fibrous material slightly treated?

A. I don't remember ever having expressed myself to that effect to Mr. Wallace, and think it very unlikely that I would do so at the time, nor do I think that
3199 any such preference was stated to him by the company.

1967 x-Q. Did yot ever inform the Wallaces, or were they ever informed by the company, as far as you know, that you preferred a loop or arch-shaped carbon, to a straight carbon?

A. I do not remember. I think it probable that I may have done so to Mr. Thomas Wallace, but I do not recollect that I did.

1968 x-Q. What had the Wallaces then to guide them in the manufacture of these lamps, that they were
3200 to undertake?

A. Mr. Sawyer's experience and that of Mr. Myers, and sample lamps, I think. It is proper to say that the Messrs. Wallace were largely engaged in electrical work, and as I understand, had done a large amount of experimenting and other work in electric lighting, and their own judgment in such matters I suppose would guide them.

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1969 x-Q. By Sawyer's experience do you mean his statements in regard to his experience, or such as he chose to give them?

A. I mean just what I say. Mr. Sawyer was hired to go up there and aid them in the work.

1970 x-Q. Hired by the Electro Dynamic Light Co?

A. Hired under the agreement made with Mr. Wallace, the compensation for his services coming from contributions made by the company and its stockhol-
ders. 3202

1971 x-Q. The Wallaces personally did not know what his experience had been, but depended on him for information; am I right?

A. I have stated all I know about that matter.

1972 x-Q. Were you one of the stockholders that contributed for the payment of Sawyer's expensea?

A. Yes.

1973 x-Q. Did you inform the Wallaces or did the company, so far as you know, of Sawyer's habits of in-
toxication and of your experience at 94 Walker street, 3203
in the manufacture or the two hundred lamps, as to which you say he was incapable of exercising good judgment, and was changing about from day to day?

A. I do not think I had any opportunity to do so before the arrangement with them was completed, and therefore think I could not have done so, nor do I think the company did or had any opportunity to do so.

1974 x-Q. In your 1967th answer you speak of sample lamps that you think Wallace had to go by. Are you quite confident that he had sample lamps? 3204

A. I only know that sample lamps were furnished by the company to Mr. Sawyer for use at the Wallaces; and I know in the fall following that a claim was made upon Mr. Wallace by Mr. Sawyer for lamps which he claimed the company had given to him, and which I think Mr. Wallace settled with him, rather than to have a fuss, of this I am not confident whether he

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settled with him or paid him, or not; I think he did.
1975 x-Did any of those sample lamps have conductors of fibrous carbon slightly treated?

A. I do not know. Mr. Sawyer himself selected them from a barrel of lamps which was stored in the upper story of the building, No. 3 Mercer street, where I had my office.

1976 x-Q. Did any of them have looped or arch-shaped carbons?

A. I made the same answer.

3206 1977 x-Q. Did the company ratify or approve Sawyer's selection?

A. No further action was taken on it.

1978 x-Q. Did you, or the company, know at the time what lamps he secleted?

A. No, I don't think any of us did except Mr. Sawyer. Mr. Sawyer also was permitted by the company to take for his own use a considerable number of the lamps at the time when we broke up at 94 Walker street.

3207 1979 x-Q. Was the arrangement made by the Electro-Dynamic Light Co. with the Wallaces in writing?

A. The arrangement with the Wallaces was made by Mr. Sawyer alone, afterwards ratified by the company and a license to them was reduced to writing, and I think executed by the company and Mr. Wallace, which was afterwards surrendered and cancelled, and lost or destroyed, at least I made a diligent search for it and could not find it.

1980 x-Did that agreement ever get into the pos-
3208 session of the complainant so far as you know?

A. I do not know. I did not believe it did.

1981 x-Q. Did that license include the invention of the patent in suit in its terms, so far as you know?

A. I think it did, but I do not know. If it was covered it was under a general heading, covering all inventions owned by the Electro-Dynamic Light Company having reference to electric lighting and dis-

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tribution of current of electricity, &c., &c., and not by specific reference.

1982 x-Q. Did the Electro-Dynamic Light Company or did you so far as you know, ever inform the Wallaces of the invention of the patent in suit?

A. I do not remember.

1983 x-Q. Who was president of the Electro-Dynamic Light Company at this time?

A. I was president during the negotiations and Mr.
Thomas Wallace became president through the
negotiations and entered upon his duties as such, and 3210
I became vice-president, and I remember that by a
resolution of the company, I was directed to execute
the license, by reason of Mr. Wallace being president
and interested as one of the licensees.

1984 x-Q. I understand that after the arrangement
with the Wallaces fell through and the license was
cancelled, the Eastern Electric Manufacturing Com-
pany which had been previously formed by Sawyer as
a hostile company, acquired all the patents and in-
ventions of the Electro-Dynamic Light Company, and 3211
after they had been so acquired, manufactured some
lamps. Am I correct?

A. That is subtantially correct. The license to the
Messrs. Wallaces was surrendered by them through
negotiations with the Electro-Dynamic Light Com-
pany just previous to and in contemplation of the sale
of the patents to the Eastern Electric Manufacturing
Company. That company made some lamps with
which they made exhibits in Philadelphia, St. Louis,
Chicago and Boston. I never saw them, and don't 3212
know what they were or how many there were of them.
I saw some lamps of their make in their new place in
Fulton street. I think all this was done under the
superintendence of Mr. Sawyer.

1985 x-Q. The patents afterwards became the property of the complainant?

3313 A. Yes.

1986 x-Q. And the complainant has manufactured and sold incandescent lamps?

A. Yes, in large numbers.

Ajourned till Friday, 16th, 1887, at 10½ A. M.

NEW YORK, April 26th, 1888.

3214 Present—Counsel as before, and the cross-examination of Mr. Man proceeded as follows:

2089 x-Q. On pages 403 and 401 of the printed record reference was made to the newspaper publication of certain letters of Mr. Sawyer, did you ever contradict the statement of those letters in print?

A. I do not remember to have ever published anything, and do not think I did.

3215 2090 x-Q. Are you familiar with what is known as the "squirt" or "syringe" process of making hard carbon?

A. I have heard it described and have seen it in operation in the process of making pencils and pencil points of plumbago and similar substances.

2091 x-Q. Could pencils of carbon be made by such process from hard carbon as cheaply as pencils of carbon could be made by cutting fibrous material to the desired size and carbonizing it?

3216 Objected to on the ground that the witness has stated that he was not practically familiar with the process.

A. I don't know, undoubtedly pencils of some quality, good or bad, could be made cheaply by the syringe process. I am unable to state that a good pencil of hard carbon could be made by that process, of suffici-

3217 ent tenuity as cheaply as the carbon could be made by cutting fibrous material to the desired size, or selecting it of the desired size and carbonizing it, as I think they would require further manipulation, sizing and cutting to lengths and treatment after their first production from the syringe.

2092 x-Q. Were you familiar with this squirting process in 1878 and 1879?

A. I think so, as much so as I am now.

2093 x-Q. Did you ever try it in the manufacture of 3218 carbon?

A. We tried pencils of carbon so produced.

2094 x-Q. Did you ever make them yourselves?

A. No, not to my present recollection, but I am not quite certain.

2095 x-Q. Who made them for you?

A. I think it was the Eagle Pencil Co., but I cannot state positively.

2096 x-Q. Do you remember what license fee Wallace was to pay the Electro-Dynamic Light Co. on each 3219 lamp?

A. I do not remember now, but by reference to the testimony on some of these previous cases, I see a resolution of the Electro-Dynamic Light Company's trustees fixing it at three dollars per lamp. I assume this was correct and believe it to be so.

2097 x-Q. What did you estimate one of your lamps would cost to manufacture?

A. I don't know. We hoped to be able to make the lamps as cheaply as a quarter of a dollar apiece, but 3220 we never did build any so cheaply as that that were permanent lamps, nor nothing near it.

2098 x-Q. In several parts of your testimony you speak of your "workshops." By these I understand you to refer to your shops at 43 Centre street, Howard and Centre and Walker and Elm streets. Is that right?

A. It is.

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2999 x-Q. In the "Scientific American" of Dec. 7, 1878, is printed an article headed "The Sawyer-Man Electric Lamp." Do you know how such article came to be published?

A. Yes; a gentleman from that paper came to the office, or workshops, 94 Walker street, and got the information, and as I understood, wrote, and the paper published that article.

3000 x-Q. Got it from whom?

3222 A. From Mr. Sawyer and myself. We did not procure or pay for the publication, but consented to it.

3001 x-Q. In the Weston-Sawyer-Man interference the following newspapers containing reference to the Sawyer-Man, and Sawyer lamp, were offered in evidence by your counsel: The Journal of Commerce, N. Y., Oct. 30, 1878; Commercial Advertiser, N. Y., Oct. 30, 1878; Evening Post. N. Y., Oct. 30, 1878; Tribune, N. Y., Oct. 30, 1878; The World, N. Y., Oct. 30, 1878; Philadelphia Record, March 25, 1880; Boston Post,
3223 March 17, 1881; Beverly Banner, Nov. 13, 1880; Public Ledger (Philadelphia), Oct. 28, 1880; Boston Morning Journal, March 17, 1881, same paper of March 18, 1884; Daily Evening Traveler, March 17, 1881. Do you know how the several articles referred to came to be printed?

A. I only know in regard to the articles in the New York papers of Oct. 30, 1878. As to those articles, I have to say that previous to that time we were exhibiting the electric light at No. 94 Walker street, and the re-
3224 porters were continually running there and asking about it and wanting to publish something about it. A day or two previous to the 30th of October, to avoid their running there one after the other, they were all invited, I think, by Mr. Sawyer, to come together and see the lamps, and these articles of October 30th were the result, if I recollect rightly, of that exhibition made to the reporters. We did not procure or pay for the

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publication, but the reporters made their own reports and published what they liked about it.

3002 x-Q. You are the same Albon Man that testified in the Sawyer-Man-Keith, Sawyer-Man-Maxim and Sawyer-Man-Weston interferences, and the William E. Sawyer referred to in those interferences, and who testified therein, was your co-inventor, William E. Sawyer?

A. Yes.

Defendant's counsel offer in evidence the 3226
following:

1. Interference record and testimony Sawyer-Man-Keith interference, and the same is marked Defendant's Exhibit Sawyer-Man-Keith Record, April 26, 1888.
2. Interference record Sawyer-Man-Maxim interference, and the same is marked Defendant's Exhibit Sawyer-Man-Keith Record, April 26, 1888.
3. Interference record Sawyer-Man-Weston 3227
interference, and the same is marked Defendant's Exhibit Sawyer-Man-Weston Record, April 26, 1888.

Cross-examination closed.

Adjourned subject to agreement of counsel.

New York, May 29, 1888. 3228

Met pursuant to agreement of counsel.

Counsel for the respective parties present as before.

Re-direct examination of Albon Man.

3003 R-d Q. In response to question 10 of your examination-in-chief you say you do not recollect of hav-

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ing used cane in making your incandescent conductors
in the spring of 1878. Please to state what you recol-
lect as to the use of cane for that purpose in the fall of
1878.

A. In the fall of 1878 I obtained from Crook's es-
tablishment in Fulton street (the same man who now
has a sporting material store, I think, on the corner of
Gold street and Fulton) a great variety of woods, and
among others, cane, such as so-called bamboo fish
poles are made of. I took them to our workshop, cor-
3230 ner of Elm and Walker streets, and gave them to Mr.
Myers to be carbonized and tried for the conductors of
electric lamps; I think they were all carbonized and
tried, but I have no recollection of conductors made
from this cane as distinguished from the other woods
that we used.

3004 R-d Q. Please to produce, if you can, speci-
mens of endogenous woods having interlacing fibres
such as you carbonized in the spring of 1878, as you
have stated, for your incandescent conductors.

3231 A. I produce a specimen of the wood of the Grugru
palm which has such interlacing fibres, although not a
good specimen of the interlacing fibres of that wood.
Whether the wood we used was of this kind or not, I
do not know, but it was with more interlacing fibres
than this, and similar in appearance, but more dense.
I also produce a specimen of so-called mangrove, a
wood growing in the West Indies and in the Island of
Bermuda, with interlacing fibres. I think this wood is
3232 properly guaiacum, which is commonly called, together
with other woods of similar character, growing in the
same localities, lignum vitæ, and is known in the
neighborhood of its growth as mangrove. We used
lignum vitæ wood, carbonizing and making conduct-
ors from it, in the spring of 1878. From investigation
of the growth of this wood, I am convinced that it is
both an endogenous and an exogenous wood; exogen-

3233
ous in the main, but endogenous in the filling up of
the ærial roots which it puts forth from its branches,
and which become filled up by an endogenous growth,
to become new bodies for the tree, and afterwards take
an exogenous growth. It is a good specimen of inter-
lacing fibre.

3005 R-d Q. These woods, as I understand you,
you carbonized, among others, in the spring of 1878,
for the purpose of ascertaining whether or not they
would make satisfactory incandescent conductors for 3234
your electric lamp?

A. Yes.

3006 R-d Q. Did you carry the experiments far
enough to ascertain whether or not such woods would
make satisfactory incandescent conductors. I am re-
ferring now to the woods having the interlacing fibers,
and if so please to state what the result of your ex-
periments was.

A. Yes, we made straight pencil conductors of these 3235
kinds of woods, cut to size and then carbonized; which
were good conductors, but found no corresponding ad-
vantage from the interlacing fibre over the straight
fibre to compensate for the greater difficulty of work-
ing out the pencils from the inlacing fibre wood.

3007 R-d Q. These specimens which you have pro-
duced, are they part of the identical interlacing fibre
wood used by you in the spri g of 1878?

A. No; they are only similar woods.

The specimen woods are effered in evidence 3236
and marked respectively "Complainant's Ex-
hibits 'Grugru palm' and 'mangrove' pro-
duced by Albon Man, May, 29, 1888."

3008 R-d Q. What, if anything, do you know of pa-
per made of bamboo or cane fibre?

A. I have seen such paper, and have seen the pro-
cess of manufacturing or separating the fibre for the

3237 paper stock. It was at one time extensively conducted in South Brooklyn, and I saw it there.

3009 R-d Q. Is it an article now, or was it then, an article of well-known manufacture in the paper trade?

A. It was at one time, and I do not know but it is now, of domestic manufacture, and I think it is also imported from China and Japan.

3009 R-d Q. You have stated upon your cross-examination as well as upon your examination-in-chief, that in the fall of 1878, and in the winter of 1879, you
3238 and Mr. Sawyer had reduced your lamp to a good practical operative condition, and that the Electro Dynamic Light Company had by that time taken measures to have the lamps manufactured and put in public use on a commercial scale. Now please to state, in a connected way, why the Electro Dynamic Light Company did not proceed with the manufacture and introduction of these lamps into public use, and state generally what efforts were made and what was done toward the manufacture and introduction of the lamp
3239 by that company and its successors?

A. After we had got the lamp and other apparatus in a substantially practical shape, in the fall of 1878, the company decided to go on to the manufacture and introduction of the lamps into use. Mr. Sawyer was one of the inventors, and he and I were the only persons understanding the work in all its details and nicety. I was absorbed in business, and Mr. Sawyer was the superintendent. His habits of inebriation and dissipation were such after this determination was
3240 reached by the company as to interfere with the work more and more, that the last of March or first of April, 1879, the company decided to stop work under Mr. Sawyer's superintendence. In the meantime, Mr. E. L. Myers had become conversant with the details of the work, and an arrangement was made by which the Messrs. Wallace, of Ansonia, who were largely interested and had been for a long time, in electrical de-

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velopment, to go on with the work and manufacture of the lamps and other apparatus, and put them into use under a royalty to the company of so much per lamp for each lighting plant they should establish. Mr. Myers went with them, and I think Mr. Sharp, a skilful workman who had been in our employ. Mr. Sawyer was hired and paid by the Electro Dynamic Co., or its stockholders, to also go to Ansonia and give his time and attention and the benefit of his knowledge, for some months, to the work. Mr. Thomas Wallace became president of the Electro Dynamic Co., and the 3242
work was commenced. Mr. Sawyer's inebriate habits immorality and dissipation so interfered with the work and disgusted the Messrs. Wallace that they would have nothing to do with him; he left, and as soon as his term of service, for which he had been paid, expired, or perhaps before, he came to the company and requested and demanded a personal license to himself for our inventions, although an exclusive license had before then been given to the Messrs. Wallace. This the
company refused and Mr. Sawyer went off and went to 3243
work to organize a rival company. Mr. E. L. Myers, about the time Mr. Sawyer left, was taken sick and went to his home in Plattsburgh, New York, where he lingered along for a while and died. There was no one but he (Myers), Mr. Sawyer and I who understood the details of the work. During his (Myers') sickness it was thought best by the Messrs. Wallace and the company that the work should be suspended until he recovered and was able to take it up. My business was
such that I could not give attention to it personally, 3244
and Mr. Sawyer was hostile. After Mr. Myers' death, there being no one to conduct our work, Mr. Sawyer's new company, the Eastern Electric Manufacturing Co., having been in the meantime organized, it was thought best that the two companies should be in harmony, and as a result the patents were assigned to the Eastern Electric Manufacturing Com-

3345 pany, which agreed to go on with the manufacture and introduction of the lamps into use. They did go on to manufacture some lamps, and exhibit them, and make commercial arrangements for their introduction into use. Mr. Sawyer quarrelled with them continually, and his habits were very bad, and finally that company sold out to the Consolidated Electric Light Company, which immediately went on with the manufacture of the lamps and other apparatus, and their introduction
3246 commercially, and is engaged in that work now upon a large scale.

3011 R-d Q. Your have stated upon your cross-examination that you and Mr. Sawyer frequently made your incandescent conductors of fibrous or textile material without treating them electrically after carbonization, and used such conductors experimentally in your lamps. To what extent did you practice such experimental work, and what did you prove by it as to the practical sufficiency of such conductors?

3247 A. In making the conductors of fibrous carbon from different substances and frequently in making different batches of fibrous carbon conductors from the same substances, we set them up in our lamps and ran them for the purpose of testing the quality of the carbon without treating them electrically. This was our method of testing the conductors. Each lamp was marked on a tag or label attached to it, and a record entered of its performance, usually on this label. A considerable number of these lamps proved to be good
3248 lamps. The conductors lasted well and were run for lighting our shops, and for exhibition, until the conductors gave out. Most of them gave out soon, but some, as I have said, proved to be good conductors, without treatment. But of the same conductors treated, nearly all, instead of a few, proved good. We therefore adopted the treatment as a rule, as an improvement upon the conductors, I mean the electrical treat-

ment patented by Sawyer and Man, by patent No. 3249
211,262, or some of its modifications.

3012 R-d Q. Do you wish to be understood as saying that by these experiments you satisfied yourselves that good illuminating conductors for incandescent electric lamps could be made of the fibrous material experimented upon, or used by you without treating them electrically as described by the patent referred to?

> Objected to as incompetent and irrelevant, 3250
> and calling for a conclusion of law, and not for any fact.

A. Yes, without adding to them any deposit carbon and leaving them purely fibrous carbons.

3013 R-d Q. But you considered the carbons, as I understand you, to be improved by the electrical treatment, and you therefore adopted the treatment of the carbons as a general practice?

A. Yes. 3251

3014 R-d Q. What did you mean by your answer to cross-question 310, where you say that you do not think you were diligent in applying for your patents?

A. I do not think we applied for them as soon as we might have done. We delayed for various causes our applications, but we always made them within the time prescribed by the law, two years.

3015 R-d Q. This invention, as I understand you, referring to the invention of the patent in suit, was made in the spring of 1878, and more thoroughly 3252
tested and perfected in the fall of the same year. Now please to state when it was first explained to your solicitor and directions given to him to apply for a patent for it?

A. In the month of October, 1878, about the middle of the month Mr. Sawyer and I explained the whole subject matter to Mr. Broadnax, solicitor for the

3253 Electro-Dynamic Light Co., and I as president of the company then requested him to apply for patents for this invention. Mr. Sawyer wrote out a statement of it, I think at that time, which was handed to Mr. Broadnax. Renewed applications and requests were made to Mr. Broadnax by me and I think Mr. Sawyer, until we parted the last of March or first of April, 1879, or certainly up to some time in January, 1879, from which time Mr. Sawyer was averse to making any
3254 applications, and from about the 1st of April, 1879, absolutely refused to sign any new applications, and thereafter never did sign any new applications for the inventions of Sawyer and Man as joint inventors, except under some special arrangement by which he thought he was to obtain some personal advantage.

3016 R-d Q. Then, as I understand you, all the time that elapsed after the invention was explained to Mr. Broadnax and he was directed to apply for a patent for it until the time that the application was actually
3255 filed, was from the middle of October, 1878, until the 9th of January, 1880, about fifteen months?

A. Yes, that is correct.

3017 R-d Q. During this time was the invention in public use?

A. No, not to my knowledge, untill the latter part of the fall or the first of December, 1879. I first heard of it the latter part of December, 1879, as being put to use by Mr. Edison, from a publication in the New York Herald in the latter days of December, 1879.

3256 3018 R-d Q. What, if any, effort was made to keep all knowledge of the invention from the public from the time it was made down to the time that you saw its use published by Mr. Edison in December, 1879?

A. We (Sawyer and I) always cautioned our workmen not to say anything about what we were doing. We never explained to the public who saw lamps with this kind of carbon in them, how the incandescent

3257 burners were made or of what kind of carbon they consisted, because the thing was not patented, but we did explain the matter to our friends and to some of the stockholders of the Electro-Dynamic Light Co., and to Mr. Broadnax, the solicitor of that company, and possibly to a few other people in confidence, whom we were endeavoring to interest with us in our electric lighting scheme, and it was our custom to keep our workshop and laboratory locked, and exclude persons not interested with us from the same, did not explain 3258
our inventions or speak of them to parties not interested with us, unless in exceptional cases where we desired to interest them and get them to come in with us, and there was a door between our workshop and the room in which our exhibitions were made at 94 Walker street, which was kept locked when exhibitions were being made or the lamps were being exhibited.

3019 R-d Q. Now, as I understand you, it was in the latter part of December, 1879, that you first knew of any one else having made or obtained knowledge of 3259
the invention of the patent in suit, and your application for such patent was made on January 9th, 1880. Is that correct?

A. Yes, except such persons as were interested with and friendly to us, who obtained the knowledge from us, and I mean that the first knowledge I had of any one else but us making use of such invention was in the latter part of December, 1879, though it may have been that I heard of Mr. Edison's making use of paper 3260
a short time prior to the publication in the Herald of December 21, to which you refer, but only a few days or a short time previous.

3020 R-d Q. Referring now to cross-question and answer 546, upon what did you predicate your expectation that a complete system of incandescent lighting would be worked out by Mr. Sawyer by the last of March, 1878?

A. Upon his statement to me to that effect.

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3021 R d Q. Referring now to cross-question and answer 758, please to state how thick the sheets of paper and the paper stock was from which you made the incandescent conductor by the method described in your answer to that question?

A. The papier mache that we turned out in the lathe was from a sixteenth to an eighth of an inch thick. The paper sheets worked out on glass plates or laps before working were about a thirty-second of an inch thick. The papier mache worked out on the glass
3262 plates or laps was somewhat thicker, perhaps a twentieth of an inch thick before working.

3022 R-d. You say also in answer to question 750

> "We also cemented masses of carbon not of the shape or size of the conductor required."

what was the shape and size of such masses of carbon of which you made the incandescent conductor by the method referred to in that answer.

3263 A. Flat piece of carbon made of charcoal, papier mache carbon, paper carbon and flat sheets of mineral carbon of a size and thickness to turn out a conductor from in the lathe.

3023 R-d. What was the length and tenuity of the incandescent conductors made by you by the methods described in your answer 750?

A. The smallest cross-section would be, I think, equivalent to the twentieth of an inch or less in diameter, the greatest length, that of the circumference of
3264 a circle, of an inch in diameter. Some of them were very much larger and shorter than these dimensions; some less than half an inch in length and some as large as the twelfth of an inch in diameter. Some of the longest were of the smallest cross-section.

3024 R-d. You have stated that by these methods you made incandescent illuminating conductors from mineral carbon as well as from carbon of fibrous origin.

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Of which of these carbons did you make conductors of the greatest length and tenuity?

A. The fibrous carbon. The mineral carbons were all comparatively short and thick.

Adjourned till Thursday morning at 11 o'clock.

THURSDAY, May 31, 1888. 3266

Met.

Present—Counsel as before; and the re-direct examination of Mr. Man was continued as follows:

3025 R-d. Referring again to your answer to cross-question 750, at what period of your work with Mr. Sawyer in making your incandescent electric lamps did you use the method described in that answer of making the 3267
incandescing conductor?

A. In the early part of our work while at 43 Centre street, in the spring of 1878.

3026 R-d. How long did you continue to practice that method of making such conductors?

A. With the mineral carbons, straight pencils, we sometimes cemented them to a lap of glass and rubbed them down to make them thinner and more tenuous and sometimes I think we used the same method with straight pencils cut out of deposit carbon pure and simple after the process described in our patent, of 3268
manufacturing deposit carbon conductors, to smooth them off and make them a regular size throughout their length, till about the 1st of January, 1879, but as soon as we established in our minds the advantages of cutting the fibrous material to shape and size before carbonization for conductors we no longer practiced the working down of fibrous conductors, I do not think we did anything of this kind with the fibrous conduc-

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tors after the 1st of April, 1878 (it may, however, have been a little later than that), unless in some exceptional case, and none occurs to me now. It was better and more convenient to make the fibrous material to shape and size and then carbonize it.

3027 R-d Q. Do you mean to be understood that you continued to use that method more or less in cases where you used mineral or deposit carbon, down to about the 1st of January, 1879, but that in the case of the incandescing conductors, made from fibrous or tex-
3270 tile material you did not use it after about the first of April, 1878, as you now recollect ?

A. Yes, that is substantially what I mean, that is, that we sometimes and exceptionally used it with a hard carbon up to the 1st of January, 1879, but that I recollect no such use of it with fibrous carbons after about the 1st of April, 1878, but we cut or formed the fibrous carbon to size and shape before carbonization and did not work them down after they were carbonized.

3271 3028 R-d Q. Why did you discontinue that method of making your incandescing conductors from carbon of fibrous origin ?

A. For the reason that they were easier made and better carbons if made by cutting or forming the shape and size before carbonization. In short, it was *possible* to make these conductors in that way, but it was not *practical*, for in addition to the mechanical difficulty of making the conductor in that way, the carbon was not pure and homogenous.

3272 3029 R-d Q. Referring now to cross-question 852 in which it is inferred that you had compared incandescing conductors made from fibrous or textile material with incandescing conductors made from deposited carbon, pure and simple, for the purpose of ascertaining which of two conductors of the same size and shape were the best ; did you ever make such comparison ?

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3030 R-d Q. Of what size and length were such conductors used in making such comparison ?

A. They were of comparatively short lengths, the longest possibly an inch or an inch and a half in length, the shortest about half an inch in length. Their size was various from extreme tenuity or less than a thirty-second of an inch up to possibly a twelfth of an inch in cross-section. I do not know that any of the carbons of the smallest cross-section, were of deposit carbon pure and simple.

3031 R-d Q. Have you ever made, or do you know 3274
of any method that has ever been practiced of making an illuminating conductor composed of carbon obtained "by electric action, pure and simple," having the length and tenuity of the illuminating conductor in the defendant's lamp Exhibit No. 21, by which the quality of such conductor could be compared with a conductor of equal length and tenuity made of fibrous carbon ?

A. I have never made a conductor of the tenuity and length of that contained in the Exhibit referred to
of carbon obtained by electric action, pure and simple, 3275
and I know of no method that has been practiced of making a conductor of this length, and tenuity of carbon obtained from electric action, pure and simple, by which such a comparison as you mention could be made between such a conductor and a conductor of the same tenuity and length made from fibrous carbon. I had not intended to testify that I had made a comparison between two such conductors of such length and tenuity.
I will add, that for the purpose of determining the
quality of the carbon, of which the conductor is com- 3276
posed, or for determining the character of the conductor, I do not think it would be necessary to have conductors for comparison of the length and tenuity of the conductor in the exhibit referred to, and I do not think that comparison between two such conductors of the same tenuity and shorter length is sufficient to ascertain the quality of carbon of which the conductors

3377 are composed, and the character of the conductors, and I intended to be understood in testifying as having made such a comparison.

3032 R-d Q. Which of two conductors of the length and tenuity referred to, the one made of fibrous or textile material and the other of carbon obtained by electric action, pure and simple, would you consider the best conductor for incandescent electric lighting? I am referring to the length and tenuity of the conductor in the defendant's lamp, Exhibit No. 21.

3278 A. The one, the fibrous conductor, is an article readily made and practical. The other, the deposit carbon conductor, I have testified that I have never made, and know of no practice by which it is made of such length and tenuity.

3033 R-d Q Referring now to your method of making or treating carbons, described in the patent to Sawyer and Man, 211,262, assuming the illuminating or incandescent conductor made of carbon of fibrous origin, treated to the minimum extent described by you, both
3279 upon your cross-examination and your examination in chief, could you, after such treatment, separate the fibrous carbon from the deposit carbon?

A. No.

3034 R-d Q. Is it or not true, then, that the body of the illuminating conductor, after such minimum treatment, remains a conductor substantially of carbonized fibrous or textile material?

A. It is true that it so remains almost wholly of carbonized fibrous material, and of the same texture as
3280 before treatment, so that if the carbonized fibrous material were removed, there would be nothing left of the deposit carbon, even if it were in one mass or line, which would constitute or be a conductor, that mass or line would require a microscope to find it, but as the deposited carbon in the treatment would be distributed upon the fibres of the fibrous material, the deposited

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carbon for each individual fibre of the conductor would be separate and by itself, constituting lines of hollow tubes of the size of the ultimate fibres of the fibrous conductor, and the shells of these tubes would be so extremely thin and fragile as to crumble to dust with the slightest touch.

3035 R-d Q. State whether or not, as the result of your experience, the fibrous carbon illuminating conductor by the treatment of it according to the process
described in the Sawyer-Man patent is improved when 3282
such treatment is carried to the minimum extent mentioned by you in your testimony.

A. My experience is that it is improved.

3036 R-d Q. Referring to cross-question 1670 please to state in what places the incandescent lamp, as made by you and Mr. Sawyer, would be capable of competing with gas as stated in your answer to that question?

A. I do not think I could enumerate all the places where it would so compete with and drive out gas. I
will mention such as occur to me; for the head lights of 3283
locomotives, for use on steamships, especially in signalling at night; for use in places in which explosive gases existed; for use in mills where safety from fire is desirable, especially in flouring mills, sugar works and the parts of cotton mills where lint and dust are liable to cause fire or explosion; for use with the camera, and in all places where an intense light derived from substantially one focus is desirable; for use in lighting under water; for use in lighting for ornamentation, such
as ornamental grounds and groves; for use as an illus- 3284
trative apparatus in colleges and schools; for use where water-power was available and cheap and near at hand for ordinary illumination.

3037 R-d Q. State, if you know of any way, that has ever been practiced of making a carbon incandescent conductor of the length and tenuity used in the incandescing electric lamps of to-day of fibrous or textile

3285 material other than by cutting, selecting or forming it to size before carbonization?

A. No, I do not.

Adjourned till Friday, June 1, 1888.

FRIDAY, June 1, 1888.

3286 Met.

Present—Counsel as before, and the Re-direct examination was continued as follows:

3038 R-d Q. Please to produce, if you can, a specimen of the cane obtained by you at Crookes' establishment in Fulton street in the fall of 1878, as mentioned in your answer to re-direct question 3003.

A. I produce a specimen of such cane which I recently obtained from Mr. Crookes.

3287 3039 R-d Q. This cane, as I understand, you gave to Mr. Myers or some other workman in your shop, with directions to to carbonize and make incandescent conductors of it?

A. Yes, to Mr. Myers.

> Specimen of cane offered in evidence and marked Complainant's Exhibit No. , East India Cane, produced by Albon Man, June 1, 1888.

3288 3040 R-d Q. Now, in making your longest and most tenuous incandescent treated conductor of fibrous carbon, how did you proceed in cases where such conductors were to be subjected to the minimum treatment according to the process of the patent of Sawyer and Man, 211,262?

A. We selected the fibrous material of the size and length desired, formed it to shape, and, then carbonized

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it, and then treated it, or if the selected material was not already of a desired size, we formed it to the size desired, put it in the shape desired, then carbonized it and then treated it.

3041 R-d Q. Now, in making your incandescing conductors of pure deposited carbon obtained by electric action, how did you proceed?

A. In the same manner as in the last answer, using selected fibrous material, selected or formed to
size and shape, then treating it by the electrical pro- 3290
cess until the deposited carbon was of sufficient thickness of itself to form a conductor, then removing the vegetable fibrous carbon, leaving a conductor of pure deposit carbon.

3042 R-d Q. In both cases, as I understand you, you began with an incandescing conductor made of carbonized fibrous or textile material?

A. Yes, a conductor of that kind selected or formed to shape and size before carbonization?

3043 R-d Q. Why did you use in the production of 3291
such conductors an incandescing conductor, made of carbonized, fibrous or textile material selected or formed of the proper size previous to carbonization?

A. In the first case, because we wanted to make a conductor for use in the lamps of carbonized fibrous material, only improved by the electrical treatment and we knew of no other way in which long and tenuous conductors, such as some of those that we used, could be practically and easily produced except by the use
of the fibrous carbons selected or formed to size and 3292
shape before carbonization. In the second case, that of the deposit carbon, pure and simple, we used the incandescing conductor of fibrous carbon selected or formed to shape and size before carbonization, in order to give the same shape to the deposit made upon it and we used the fibrous carbon; vegetable carbon, for this substratum on which the deposit was formed, be-

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cause the vegetable carbon was soft and could be readily removed after the deposit was formed upon it, to leave the pure deposit carbon incandescent conductor. If we had used hard or mineral carbons for this purpose they were too hard to be removed and separated by tools from the deposit carbon, pure and simple, of which we wished to form a conductor, and the attempt to remove them would break the deposit carbon.

3044 R-d Q. In the production of these conductors
3294 then, as I understand you, an incandescing conductor of carbonized fibrous or textile material was necessary to begin with?

A. Yes, we deemed it so.

3045 R-d Q. You have stated that the Wallaces, of Ansonia, were to manufacture your lamps under a royalty. Please to state what that royalty was to be and what it included?

A. My recollection of the thing is that they were to pay a royalty of three dollars per lamp for the use of
3295 all the inventions of Sawyer and Man, owned by the Electro-Dynamic Light Co., based upon the number of lamps in the different lighting systems or plants that they should establish. As an illustration, if a plant established by them was one containing a hundred lamps the royalty would be once for all, three hundred dollars, notwithstanding the lamps might be renewed in the same plant.

Adjourned to June 13, 1888.

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New York, June 13, 1888.

Met pursuant to agreement of counsel.

Present—Counsel as before, and the re-cross-exam-

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ination of Mr. Man was commenced and continued as follows:

3046 R-x Q. When testifying on your direct examination in this suit did you recollect the getting of any bamboo for carbonization?

A. My recollection on the subject has been refreshed since I testified in regard to the matter. In my direct examination I recollected getting them somewhere and trying some endogenous wood of the larger or tree growth, such as some of the palms. I 3298
do not know which. If I knew, I have forgotten, and have forgotten where I got them. Since then I went to Crookes' place in Fulton street, corner of Cliff street, to get some lance wood, such as I got from him and tried in 1878, and had my attention called to the getting of a great variety of wood from Crookes at that time which I took to 94 Walker street, carbonized, and had tried for the conductors of incandescent lamps, among which was another endogenous wood 3299
that I have not mentioned, that I am satisfied I then got and took to be tried at our work-shop, No. 94 Walker street, with the other woods that I got from Crookes'. I have no further recollection in regard to the matter than that I got this wood, took it to our shop to be carbonized and tried, and have no recollection of the carbonizing and trying of this wood as distinguished from any of the others.

3047 R-x Q. Who was it that called your attention to the getting of a great variety of woods from Crookes'? 3300

A. I knew that I had got a variety of woods from Crookes' and my attention was called to the subject matter by a young man that I have known as Harry Crooke, and the circumstances attending the getting of the wood were recalled by him and recollected by me;

3048 R-x Q. What did he say to you?

A. He said that he took me up into the work-shop

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where his father, or adopted father, as I have since learned he was, was at work selected the woods, while there, called my attention to several of them, among others this one endogenous wood (bamboo) which his father was then working, showed me the working of the wood which was then very peculiar and ingenious and gave me samples of it with the other woods.

3049 R-x Q. This you had forgotten all about, as I understand?

A. Yes; I had not thought of it until that time.

3302 3050 R-x Q. Is it now your recollection that he suggested your taking this piece of bamboo and that you did not ask for it?

A. No, it is not. It is my recollection that I asked him for strong fibrous woods, all the kinds he had and that he took me up into the workshop to see what they had and showed me the different kinds of woods that his father was working—the bamboo, and that he showed me the process of manufacture and that I asked him for the pieces of it.

3303 3051 R-x Q. You have, I understand, no recollection of having carbonized or tried it?

A. No, sir, not as distinguished from any of the others?

3052 R-x Q. Did you ever get any more bamboo?

A. No, I don't think I ever did. I do not know that this was bamboo proper, it was cane, such as so-called split bamboo fish poles are made of.

3053 R-x Q. What do you mean by saying in your 3051st answer "not as distinguished from any of the

3304 others?"

A. The carbonizing at 94 Walker street, and preparing the conductors was mostly done by Mr. E. L. Myers, some of the shaping by Mr. Sawyer. The woods I got were mostly prepared and carbonized by them and I believe that all the different kinds were tried that I took to the shop, but I am unable at this length of time to recollect and distinguish all the

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different kinds of woods, nor to testify, and I know that I have not named all that we got and all that were tried, but I am unable to testify positively in regard to several of the different kinds that I recollect, their individual use and trial. Among these is bamboo.

3054 R-x Q. All that you know then is that getting a great variety of woods at Crooks', you got some bamboo, under the circumstances you have mentioned, and took it to the workshop to be used?

A. Yes, with the addition that I gave directions for the woods that I took there to be tried. 3306

3055 R-x Q. But whether bamboo was tried or not, you do not know?

A. I cannot answer; I cannot testify positively that it was.

3056 R-x Q. In answer to your 3004th question you refer to woods having interlacing fibres, do you remember what the kinds of woods having interlacing fibres that you tried were?

A. I don't know. It was one with interlacing fibres; I would know it if I saw it again, and have tried to find 3307 it, but have been unable to do so.

3057 R-x Q. What endogenous woods have interlacing fibres?

A. The larger or tree growths, such as some of the palms, I think.

3058 R-x Q. Were conductors ever make from this endogenous wood?

A. Yes, some straight pencils were made from it.

3059 R-x Q. Was this wood tried to any extent?

A. Not very extensively. A few batches of pen- 3308 cils were made from it.

3060 R-x Q. How did it compare, in your estimation, with willow?

A. The conductors were very troublesome to make. They were good enough, but no preference was established for them in any way, and if I recollect rightly

3309 we thought the carbon was not as pure as the willow carbon.

3061 R x-Q. In your 3007th answer, referring to the woods produced by you, you say they are similar woods to the endogenous woods with interlacing fibres which you tried. If I am correct in understanding you, you do not mean that you remember trying Grugru palm and mangrove; but what you do mean is that they are similar to these in being endogenous and having inter-
3310 lacing fibres?

A. As to the Grugru palm you are correct; but as to the mangrove, we did use lignum vitæ, of which I understand the mangrove to be a species. As to this kind of mangrove, it is not mainly an endogenous wood, but only, if I am right, takes on the endogenous form of growth in part only as to the interior of its ærial roots, which I think, from my investigation, are filled up so far as the pith or interior of these roots are concerned by endogenous growth, and also take an exoge-
3311 nous growth after they reach the ground and become new bodies for the trees. There are several kinds of woods which are commonly called in the neighborhood of their growth, mangrove. This one that I produce is called there mangrove and is lignum vitæ, whether there are other kinds of lignum vitæ I do not know. I only know that this kind of wood which I produce looks like that which we used which was called lignum vitæ.

3062 R-x Q. In your 2010th answer you say the com-
3312 pany decided to go on with the manufacture and introduction of the lamps into use. How was this decision evidenced?

A. It was a decision reached at a board meeting of the company's trustees, and, I suppose, recorded in the minutes.

3063 R-x Q. Do you know where these minutes are?

3313

A. No, I do not.

3064 R-x Q. Was it explained to the board what lamp and apparatus the company had which they considered in practical shape for introduction?

A. I do not remember

3065 R-x Q. Do you remember what the lamp was and what the apparatus which it was decided to introduce and manufacture?

A. Only that it was like those which had been produced up to that time, and leaving a discretion as to 3314
modifications to the superintendent.

3066 R-x-Q. What apparatus other than lamps were to be manufactured and introduced?

A. Switches, resistances, regulators, meters, safety devices, cut outs and holders and connections for the lamps.

Adjourned till Wednesday, the 13th inst., at 10½ A. M.

3315

New York, June 13, 1888.

Met pursuant to adjournment.

Present—Mr. Broadnax for complainant and the witness; and after waiting an hour and a half, and no one appearing on behalf of defendant, the further examination of Mr. Man was adjourned till Thursday, the 14th inst, at 1 P. M.

3316

Thursday, June 14, 1888.

Met pursuant to adjournment.

Present—Mr. Broadnax for complainant and the witness. No one appearing for defendant the examination was adjourned till Friday, the 15th inst., at 1 P. M.

3317

FRIDAY, June 15th, 1888.

Met pursuant to adjournment.

Present—Mr. Broadnax for complainant. No one appearing for defendant, the examination was adjourned till Monday the 18 h, at 11 A. M.

3318

NEW YORK, June 18, 1888.

Met.

Present--Counsel for the respective parties and the witness, and the examination of Mr. Man was continued as follows:

3067 R-x Q. You speak of the apparatus the company decided to manufacture, please state what facili-
3319 ties for manufacture the company possessed?

A. I have already stated that fully. We had a workshop, tools and apparatus which I have named, and we had work made outside at a great variety of places.

3068 R-x Q. Was it intended to do the manufacturing in the workshop, or to have the articles made outside?

A. The main portion of the work was to be made outside; the setting up and assembling or putting to-
3320 gether, and some other work, such as making carbon conductors, was to be done in the shop.

3069 R-x Q. What horse power did you have available in the shop?

A. One small steam engine. I don't remember the horse power; perhaps six horse power, or less.

3070 R-x Q. How many men did the machinery in the shop admit of employing with profit?

A. Half a dozen or more.

3321

3071 R-x Q. Can you tell me at what place outside of the shop the various articles or their parts were to be manufactured?

A. I have already fully testified in regard to this matter. The glass work at glass factories, the metal work at different metal working establishments of different kinds. I have already specified these as fully as I can.

3072 R-xQ. What metal working establishments was the metal work to be done at? 3322

A. I have already, as fully as I can, testified in regard to where we got the metal work done. There was no direction given by the company, that I recollect, that the metal work, glass work, or other work, was to be done at any particular place.

3073 x-Q. Where were the switches, resistances, regulators, meters, safety devices, cut-outs and holders, referred to in your 3066th answer, to be manufactured?

A. Partly in the shop and partly outside, as the 3323
other was.

3074 R-x Q. Do you know at what places outside?

A. I do not remember that any direction was given by the company in regard to it. I cannot recollect the names of the people. They were brass founders and machinists and instrument makers and metal spinners and wire coverers.

3075 R-x Q. Did the company get any special tools or machinery after their decision to undertake the manufacture? 3324

A. Yes, a great variety of patterns and samples, and we were all the time buying tools and having them made, of different kinds.

3076 R-x Q. What special tools and machinery did the company get after its decision to manufacture, and to what extent did they go to fit up the shop so as to enable them to manufacture?

3325

A. I cannot remember at this time to particularize all the things that were got or all the things that were done.

3077 R x Q. To what expense did the company go in this direction?

A. I can't recollect the figures, but it was very large expense, thousands of dollars.

3078 R-x Q. Do you mean it spent thousands of dollars in fitting up the workshop after its decision to
3326 manufacture?

A. Not the workshop of the company alone, but the apparatus used by all the different people who were manufacturing all or most of them. The company had to pay for the special tools and apparatus of the different manufacturers necessary to produce the work cheaper and with facility, and for the time consumed in making such tools and apparatus. As an illustration: With H. L. Judd & Co., who made a large amount of metal
3327 work for us, we paid for the making of tools, or rather machines for making the metal appliances of the base of the lamp, and for making the corrugated and folded conductors leading into the lamp, and for the metal apparatus underneath and above the diaphragm within the lamp. With others we did in the same manner; paid for the fitting up to make the different parts.

3079 R-x Q. How much in all did the company pay for the special tools which Judd had to get for the purposes enumerated?

3328 A. I cannot recollect. They made them.

3080 R-x Q. About how much.

A. I can't tell.

3081 R-x Q. What other manufacturers got in special tools for the doing of your work?

A. I cannot remember to name them. Special tools were made for producing the stop-cocks and grinding them, for pressing out the caps, for covers which cov-

3329

ered the stop-cocks, for making the spun-metal caps which covered the base of the lamps, for making the clamping rings for the base of the lamps.

3082 R-x Q. How much did the company expend in special tools and machinery for its workshop after its decision to manufacture?

A. I do not know. No separate account was kept of the matter.

3083 R-x Q. Can you tell me approximately?

A. Thousands of dollars were expended as a whole, but I do not know any way of distinguishing the ex- 3330
penditures for special tools and apparatus from the other expenditures.

3084 R-x Q. Where did the company get the money they thus expended?

A. From the sale of its stock.

3085 R-x Q. What was the capital of the company?

A. I can't recollect.

3086 R-x Q. How much money was ever paid in?

A. That I can't recollect. I knew both, but it don't occur to me now; I should have to refresh my recol- 3331
lection to find out.

3087 R-x Q. Did the company keep any books showing the moneys paid in and expended?

A. Yes.

3088 R-x Q. Where are they?

A. I don't know. The last I knew of them they were with Mr. Broadnax.

3089 R-x Q. Were any meters actually constructed?

A. Yes.

3100 R-x Q. By whom? 3332

A. Two or three were partially constructed but not finished, in the workshop of the company in part, and in part, by work outside. A complete meter was made I don't know who by, after Mr. Sawyer and I separated.

3101 R-x Q. At what outstde place was the work on the meters done?

A. I can't recollect where the parts were made.

3333 3102 R-x Q. Were any regulators made outside.

A. The parts were made outside.

3103 R-x Q. Where?

A. I don't know.

3104 R-x Q. From whom were the special tools and machinery which the company got after its decision to manufacture obtained?

A. I can't recollect, a great number of people, here and there and everywhere.

3334 3105 R-x Q. You refer in your 3010th answer to an arrangement made with the Messrs. Wallace of Ansonia, was that arrangement in writing?

A. Yes.

> Counsel for defendant gives notice that they will move to strike from the record all the testimony of the witness given on his re-direct examination relating to any arrange-
> ment made between the Electro-Dynamic
> 3335 Light Co., and the Messrs. Wallace, of Ansonia, and insist upon the original paper being produced.

> Complainant's counsel, in response to the objection noted by defendant's counsel, calls his attention to the fact that it has already been proved that the agreement or contract referred to has been lost and cannot be produced.

3336

3106 R-x Q. I understand you do not know of your own knowledge what was done by the Messrs. Wallace under this agreement?

A. Only by reports from Mr. Wallace, Mr. Sawyer and————Mr. E. L. Myers, to the company, and to me as an officer.

3107 R-x Q. You say in your 3010th answer that

3337

Mr. Sawyer was hired by the Electro-Dynamic Light Co., or its stockholders, which was it?

> Objected to as immaterial and not cross-examination.

A. The stockholders contributed stock which they held, was sold, and the proceeds went to the company, and in part was paid to Mr. Sawyer.

3108 R-x Q. Had the stock of the treasury of the company been exhausted? 3338

> Same objection.

A. There was no stock in the treasury of the company, but stock was held by a trustee for the benefit of the company. I think that was not exhausted at the time.

3109 R-x Q. Why did the stockholders individually contribute their stock?

> Same objection. 3339

A. In order to induce Mr. Sawyer to go to Ansonia and superintend the work there, or advise in regard to it, and to interest Messrs. Wallace, who bought part of the stock that was sold.

3110 R-x Q. Why was not the trust stock used for this purpose?

> Same objection.

A. I do not know now, but I suppose it was for the purpose or keeping the company good, and not de- 3340
pleting it by the arrangement made with Mr. Sawyer and Mr. Wallace.

3111 R-x Q. In your 3010th answer you say the Eastern Electric Manufacturing Co., to whom the patents were assigned "agreed to go on with the

3341 manufacture and introduction of the lamps into use," with whom was this agreement made?

Same objection.

A. The agreement was between the Electro-Dynamic Light Co. and the Eastern Electric Manufacturing Co.

3112 R-x Q. Was the agreement in writing?

Same objection.

A. I don't think so, but I don't recollect positively.

3342 3113 R-x Q. What was the agreement?

Same objection.

A. Before the patents were assigned to the Eastern Electric Manufacturing Co., or to Mr. W. H. Church, and from Church to that company, an agreement, after a great deal of negotiation, was reached between the two companies. Under that agreement the assignment of the patent was made to the Eastern Electric Manufacturing Company, and that company agreed to go on
3343 and manufacture and introduce the lamps and other apparatus. Whether this agreement was reduced to writing, I cannot now recollect.

3114 R-x Q. In the same answer you say "They (the Eastern Electric Manufacturing Co.) did go on to manufacture some lamps," do you mean they manufactured them themselves, or had them made for them?

Same objection.

A. I think they did the manufacturing in part, them-
3344 selves in their workshop in Fulton street, New York, and in part had the work done outside, as the Electro-Dynamic Light Company did.

3115 R-x Q. Did they acquire the tools and machinery of the Electro-Dynamic Light Co.?

Same objection.

3345

A. No.

3116 R-x Q. What became of them?

A. I bought them from the Electro-Dynamic Light Co., such as they had in their shops, and such as I could find with the different manufacturers who had done work for the company, except the engine, some of the pulleys and shafting, and some general tools and one lathe, and perhaps some other things which were sold off to different people at the time when we closed the shop at 94 Walker street. 3346

3117 R-x Q. What have you done with them?

Same objection.

A. Part of them I stilll have, and part of them I have sold, and part of them I lent to Mr. Sawyer and never got them back again.

3118 R-x Q. Did you keep, lend, or sell the major part?

Same objection. 3347

A. I think the major part is sold, much the major part in bulk, not in value, of what I had left after lending to Mr Sawyer; I think I lent him about half of what I got.

3119 R-x Q. What did you realize from those you sold?

Same objection.

A. I don't know; I sold them at odd times. 3348

3120 R-x Q. About how much?

Same objection.

A. Two or three to five hundred dollars I should think.

Adjourned for lunch.

3349

Resumed after lunch.

3121 R-x Q. What was the value of the special tools and machinery you bought from the Electro Dynamic Light Co., exclusive of dynamo machines and experimental apparatus; I refer to tools and machinery?

Same objection.

A. I do not know how much of it was only adapted to the special work which was to be performed, and
3350 not useful for other purposes. Some of it, such as lathes, tools, and drills was good in general workshops. Some of it I sold for old junk. Some of it I gave away to get rid of it and the storing of it.

3122 R-x Q. From what persons other than the Electro-Dynamic Light Co., did you get the special tools and machinery which had been made for work to be done for that company?

Same objection.

3351 A. Some of it I got from Mr. Judd, part of what we had, and part was burned up in their factory. Some of the patterns and forming tools I got from the metal spinner in Centre street. Some of it Mr. George Sawyer went round and collected for me.

3123 R-x Q. Is Judd the only person you can mention?

Same objection.

3352 A. He is the only person whose name I recollect.

3124 R-x Q. Do you know, of your own knowledge, that the Eastern Electric Manufacturing Co. did any manufacturing?

Same objection.

3353

A. Yes.

3125 R-x Q. Did they fit up a workshop?

Same objection.

A. They had a workshop fitted up.

3126 R-x Q. Capable of manufacturing on an extensive scale?

Same objection.

A. No; I think not on a very extensive scale, and 3354
not for the complete work of making and setting up lamps and other apparatus, but for assembling and setting up the manufactured parts of lamps and other apparatus.

3127 R-x Q. Where was their workshop?

Same objection.

A. In Fulton street, New York; I can't remember where. 3355

Witness here says:

"The tools and apparatus for making glass work were most of them left at the glass factories where the glass work was done. I never got them."

3128 R-x Q. How much room did they have?

Same objection.

A. As I recollect it, one loft, or perhaps one loft and 3356
part of another, or the whole of another, I can't recollect.

3129 R-x Q. What was the size of this loft?

Same objection.

A. I should think, speaking only from recollection, twenty-five by fifty or sixty feet deep, one loft com-

3357

plete and part or the whole of another loft of the same size.

3130 R-x Q. To what extent did they go in the matter of tools and machinery?

A. I don't know. They had a large amount of tools and machinery there.

3131 R-x Q. You do not know as a matter of fact what work was done at this workshop?

3358 Same objection.

A. Yes, I know some of the work that was done. I don't know the amount. There was a whole machine shop there of very special tools and large apparatus of all kinds.

3132 R-x Q. Were these bought by the Eastern Electric Manufacturing Co. before or after its consolidation with the Electro Dynamic Light Company?

Same objection.

3359 A. I don't know, part were bought before and part after.

3133 R-x Q. You say they had work done outside. Do you know where?

Same objection.

A. No.

3134 R-x Q. What has become of the tools and machinery of the company?

3360 Same objection.

A. I don't know.

3135 R-x Q. You were a large stockholder in that company?

Same objection.

A. I was a stockholder.

3361

3136 R-x Q. Do you know where the books of that company are showing the money expended by them in machinery, tools and experiments?

A. No.

Same objection.

3137 R-x Q. Where did you last see them?

Same objection.

A. I do not know that I ever saw them, but it seems 3362
to me that they were shown to me at or about the time when the patents were assigned from the Eastern Co. to the Consolidated Co. with reference to the value of the tools, machinery and apparatus of the Eastern Co. or their cost. It may have been, however, that it was only the account of inventory that I saw and not the books.

3138 R-x Q. Who was the last person, so far as you know, in whose custody they were?

Same objection. 3363

A. I don't know that I ever knew in whose custody they were, and am not certain that I ever saw them.

3139 R-x Q. In your 3010th answer referring to this company you say "they did go on to * * * * make commercial arrangements for their introduction into use." To what commercial arrangements were you referring?

Same objection.

3364

A. A contract made with some Chicago people for the use of the lamps and apparatus at Chicago; a contract made with St. Louis people for the use and introduction of the lamps and other apparatus in St. Louis, a contract made with some Philadelphians of a like character for the State of Pennsylvania, a con-

3365 tract made with Boston people, and other contracts, I can't remember where or with whom.

3140 R-x Q. About when were they made.

Same objection.

A. After the sale of the patents by the Electro-Dynamic Co. to the Eastern, and before the sale from the Eastern to the Consolidated. I should say from some time in 1881 forward.

3366 3141 R-x Q. Were they in writing?

Same objection.

A. Yes.

3142 R-x Q. Where are they?

Same objection.

A. I don't know.

Defendant's counsel objects to any testimony in regard to the subject matter of these
3367 contracts and insists on the production of the originals.

3143 R-x Q. In the same answer you say the Consolidated Electric Light Co., after acquiring the patents, went on with the manufacture of "the lamps," &c. Do the Consolidated Company manufacture and sell a lamp similar to those manufactured in 1879 in Walker st.?

Same objection.

3368 A. Yes, in some respects.

3144 R-x Q. In what respect?

Same objection.

A. They manufactured a lamp using a fibrous carbon; they treat the carbon after the Sawyer and Man patent. They support the conductors by a separate piece, similar to the base of the Sawyer-Man lamp, or

equivalent to it; project this support into the interior 3369
of the lamp chamber, making it the equivalent of the diaphragm of the Sawyer and Man lamp. They make an arch or loop-shape carbon, similar to those that were made by Sawyer and Man. They use an exhausted or inert atmosphere, or both, as Sawyer and Man did, and they make the chamber wholly of glass, as Sawyer and Man did, and they produce light by incandescence of the conductor, as Sawyer and Man did. They make arrangements for connecting the 3370
lamp to conductors; they make arrangements in the lamp for connecting it with conductors and setting it upon fixtures, as Sawyer and Man did; and use a metal base around the bottom of the lamp, similar to the spun cap used by Sawyer and Man.

3145 R-x Q. In what lamp does the Consolidated Company use an inert atmosphere?

Same objection.

A. In all their lamps. 3371

3148 R-x Q. At what pressure?

Same objection.

A. At an exhausted atmosphere; I don't know what pressure—very small and inert by reason of the exhaustion.

3149 R-x Q. What do you mean in your 3144th answer when you say the complainants use an exhausted or inert atmosphere?

Same objection. 3372

A. Just what I said.

3150 R-x Q. Do you use the terms as synonymous?

Same objection.

A. Yes.

3151 R-x Q. In referring to the lamp made by com-

3373 plainant have you in mind one of their standard commercial lamps?

Same objection.

A. Their ordinary lamps, varying somewhat in form and in details of workmanship from time to time.

3152 R-x Q. Do you consider the present standard lamp of complainant as substantially like Complainant's Exhibits Sawyer-Man Lamp No. 3, January 12, 1888; Sawyer-Man Lamp No. 2, January 12, 1888, and Saw-
3374 yer Man Lamp No. 4, January 12, 1888, with the exception of the form and substance of the carbon conductor?

Same objection.

A. They are not similar in form or in appearance, but they are similar in principle in the respects which I have stated, and involve the use of the same patents and inventions or devices in whole or in part.

3375 3153 R-x Q. Why does the complainant manufacture and sell its present form of lamp rather than such lamps as are shown in the exhibits?

Same objection.

A. I do not know, but suppose that they consider the present form of lamp superior.

3154 R-x Q. In what respects?

Same objection.

3376 A. In improved workmanship and skill, due to manufacture, and in simplification of the parts due to manufacture and the experience of use.

3155 R-x Q. Has the complainant any installation at the present time, so far as you know, where a thousand lamps are in circuit in multiple arc?

Same objection.

3377

A. I do not know.

3156 R-x Q. Do you know whether a thousand lamps such as they now manufacture could be put in a building like this (the Equitable) in multiple arc and run from dynamos in the basement?

Same objection.

A. I don't know, I think they could.

3157 R-x Q. Have you any idea of the size of the copper wires required to be used to convey the current 3378
to the lamps in such an installation?

Same objection.

A. I have made no computation in regard to it.

3158 R-x Q. What should you say was the resistance of the conductor of the lamp Exhibit Sawyer-Man Lamp, January 5th, 1888?

Same objection.

3379
A. Less than an ohm.

3159 R-x Q. Suppose you had a thousand such lamps in this building in multiple arc fed by a current from a dynamo in the basement what would have to be the diameter of the copper conductors?

Same objection.

A. Very large. Such a lamp is not well adapted to such an installation in multiple arc. Its resistance is too low. 3380

3160 R-x Q. When did the complainant first begin to manufacture and sell lamps?

Same objection.

A. Immediately after the organization of the company. I cannot now recollect the date. It is in the record in this case. I think it was in the fall of 1882.

3161 R-x Q. Do you know whether there was then

3381 on the market a lamp having an appearance and structure of general similarity to the lamp the complainant now manufactures?

Same objection.

A. Yes, I think there were several kinds of lamps at that time on the market similar in general appearance I don't know as to their details.

3162 R-x Q. Was the Edison lamp one of those to which you refer?

3382 Same objection.

A. I think the Edison lamp was similar in general appearance.

3163 R-x Q. About when did the Eastern Electric Manufacturing Company cease to make or have made lamps for them?

Same objections.

3383 A. I think about the same time the Consolidated was organized.

3164 R-x Q. In your 3011 answer you say "each "lamp was marked on a tag or label attached to it and "a record entered of its performance." Referring to these records when testifying in the case on patent 211,262 between the same parties you said:

> "528 x-Q. Who kept the records and what has become of them?"
>
> A. Mr. Sawyer for the most part made out
> 3384 the cards, but the thing was very irregularly done and the records on the cards were very incomplete. I never knew what became of those that were thrown into Mr. Sawyer's desk, and the last time I recollect seeing any of them was in seeing them tied to a lamp that was given to Mr. Broadnax, counsel for the company, which had been handed by Mr.

Sawyer to Mr. Arnoux to hold, showing the arched form of carbon at a time when Mr. 3385 Edison published something in the newspapers referring to the loop form of carbon; and also the card attached to another lamp which I gave to Mr. Broadnax to be used as an exhibit. What was done with the cards on those lamps then I do not know.

529 x-Q. What was the object of keeping these memoranda? 3386

Same objection and notice.

A. As a guide to our experimental work.

530 x-Q. If that be so, what explanation have you to give of their incompleteness and your ignorance of them after they were thrown in Sawyer's desk?

Same objection and notice.

3387

A. Their incompleteness was due to carelessness; their usefulness was in a great measure at an end for the purpose for which they were kept when the carbons or lamps were broken, or at an end, or changed.

Is such your present recollection of the facts?

Same objection.

A. Yes. 3388

Adjourned till Tuesday, the 19th inst., at 1 P. M.

3389

TUESDAY, June 19, 1888.

Met pursuant to adjournment.

Present—Counsel as before, and the examination of Mr. Man proceeded as follows:

> Witness desired to state in addition to his last answer that since making the answers quoted in that question he has found one or
3390 two globes of lamps with cards or labels still adhering to them.

3165 R-x Q. Have you such lamps in your possession?

> Same objection.

A. There are two of the globes here present.

> The globes containing the labels are produced and marked in evidence "Complain-
3391 ant's Exhibit Globes with Labels, June 19, 1888."

3166 R-x Q. In your 3015th answer you state you explained the whole matter of the invention in controversy to Mr. Broadnax and requested him to apply for a patent in October, 1078. Did Mr. Broadnax refuse to apply for a patent?

A. I don't know that he did.

3167 R-x Q. Why did he not obey your request and apply for a patent?

3392 A. I think there were several reasons.

3168 R-x Q. Did he give you any reason why he did not?

A. Yes, he told me several times in regard to it.

3169 R-x Q. You say in the same answer, "Renewed applications and requests were made to Mr. Broadnax." Did he continue to disregard these applications and requests?

3393

A. I don't think he ever disregarded them. On the contrary, he did a great deal of work in regard to them according to my best recollection.

3170 R-x Q. What reason did he give you for not obeying your request and applying for a patent?

A. One reason was that the thing would keep; that there was time enough to make the application; that he was very busy with other work for the company; that he was endeavoring to formulate claims in regard to the matter, and that he was in doubt in regard to 3394
the patentabilty of the invention because it was charcoal and charcoal had been used before in electric lighting.

3171 R-x Q. Any other reasons?

A. I do not now remember any other statements in regard to it, for the delay.

3172 R-x Q. From October, 1878, until March, 1879, what work did Mr. Broadnax do for the company?

A. I don't think I could remember the details of the 3395
work he did, only some of it. H had a large number of applications for patents, foreign and domestic, for us, and was engaged in several interferences, to the best of my recollection.

3173 R-x Q. How many applications do you think were filed between the times mentioned?

A. That I don't remember.

> Witness desires to state that, discussion intervening, the last question was asked before he had completed his answer to the preceding
question, which he does as follows: 3396

Mr. Broadnax was also engaged in drawing contracts and agreements between the Electro-Dynamic Light Company and different people, attending the meetings of the board of the company, and made frequent journeys to Washington with reference to patents and interferences. This testimony I give as

3397 the best of my recollection of what he did and was doing for the Electro-Dynamic Light Company during the period you mention. My recollection is that his time was completely absorbed, or nearly so, with the business of the company to the suspension of other business.

3174 R-x Q. What interferences was he conducting during this time?

A. I cannot remember them to name them.

3175 R-x Q. How many times did he go to Washing-
3398 ton?

A. I don't know. My recollection is a great many times.

3176 R-x Q. About how many?

A. I can't recollect.

3167 R-x Q. Can you give no idea?

A. No, not that would give any definite information on the subject.

3178 R-x Q. What agreements or contracts did he prepare during this period?

3399 A. That I can't recollect, only some of them.

3179 R-x Q. What ones do you recollect?

A. I remember his drawing some agreements between the company and Mr. Sawyer and myself and two or three or more parties of gentlemen, called syndicates and the Electro-Dynamic Light Co., having reference to foreign patents, and these are all that I do now recall.

3180 R-x Q. Did Mr. Broadnax present bills for his services?

3400 A. Yes, I think so.

3181 R-x Q. Who to?

A. The Electro-Dynamic Light Co., I think.

3182 R-x Q. Did those bills contain a statement of the services rendered?

A. I do not know.

3183 R-x Q. Was the company informed in any way

3401 of the services performed by Mr. Broadnax?

A. Yes, they knew of everything that was done, in a general way.

3184 R-x Q. How were they informed?

A. At the board meetings.

3185 R-x Q. By oral or written statement?

A. Perhaps by both, I don't recollect. Mr. Broadnax was usually or frequently at the board meetings of the company and its officers, which were held very frequently, sometimes several times a week.

3186 R-x Q. Were his bills paid by the company? 3402

A. I think so.

3187 R-x Q. By check?

A. I don't know whether by checks or cash.

3188 R-x Q. Did the company have a bank account?

A. That I don't recollect, or whether he was paid by checks of the company or by checks of Closson & Hays, or others; I don't know if paid in checks and where payments were in cash, if any were made, whether the cash was handed to him by me or by Closson, 3403
Hays, or by other officers of the company, I don't know; I think, however, the payments were usually made by Closson & Hays, who acted as bankers for the company.

3189 R-x Q. Did the Electro-Dynamic Light Co. ever have a bank account?

A. That I don't recollect, other than an account with Closson & Hays.

3190 R-x Q. Did they have money in the hands of 3404
Closson and Hays and draw checks upon them?

A. They had money in the hands of Closson & Hays, whether they draw checks upon them I don't recollect.

3191 R-x Q. Please explain in what way the debts of the Electro-Dynamic Light Co. were paid?

A. They were paid by the Treasurer, who at the time

3405 was Mr. Jacob Hays, I think, or Mr. Lawrence Myers. Different members of the company at different times advanced money to the company, or sometimes paid some of its bills, for which the treasurer gave them credit.

3192 R-x Q. Did the treasurer make payments out of his personal moneys?

A. I do not remember that he did. He may have done so and charged it to the company till the money came into him.

3406 3193 R-x Q. Did the treasurer keep a bank account as treasurer of the company?

A. I don't know, as I have said.

3194 R-x Q. If the company had no bank account in what way did the company pay out or receive money as a company?

A. I have not said that it had not a bank account.

3195 R-x Q. You have no recollection on the subject?

A. No.

3407 3196 R-x Q. Who kept the books and accounts of the company?

A. I think a clerk of Closson & Hays.

3197 R-x Q. Where were the books kept?

A. At their office, corner Nassau and Pine streets.

3198 R-x Q. Where was the stock book kept?

A. There.

3199 R-x Q. Who wrote up the minutes?

A. The secretary.

3200 R-x Q. Who was he?

3408 A. I can't recollect; a part of the time Mr. Sawyer.

3201 R-x Q. Where was the minute book kept?

A. At the same place.

3202 R-x Q. Where was the office of the company?

A. At the same place.

3203 R-x Q. Were the board meetings held there?

A. Yes, and at the workshops of the company.

3204 R-x Q. Are Closson and Hays in business now?

A. I think not.

3205 R-x Q. Who composed the firm? 3409

A. I don't know; I know some of them.

3206 R-x Q. Who?

A. Mr. Closson and Mr. Jacob Hays.

3207 R-x Q. Are they living now?

A. I think they are.

3208 R-x Q. Were either of them a director or officer of the company?

A. Both of them, I think. I am not certain as to Mr. Closson. 3410

3209 R-x Q. Do you remember how much Mr. Broadnax's bill amounted to for the period mentioned?

A. I do not.

3210 R-x Q. Do you know what has become of his bills or receipts?

A. I do not.

3211 R-x Q. Nor of the books of the company?

A. No.

3212 R-x Q. Were you or the company dissatisfied with Mr. Broadnax's failure to apply for a patent? 3411

A. I only remember in regard to that, being urgent with Mr. Broadnax that the thing should be done, and his rendering excuses in regard to it or giving reasons for the delay.

3213 R-x Q. Do you remember whether you were satisfied with the reasons he gave?

A. I do not remember. I should think his reasons for delay, such as giving his attention to other matters more pressing, instead of to this particular case, were satisfactory to me at the time; but I did not agree 3412 with him as regards to the patentability of the invention, and frequently argued that question with him, and got him to go to the shops to see the thing and be better informed.

3214 R-x Q. You speak of arguing the question of patentability with Mr. Broadnax. Please tell me what

3413 position he took on the subject in these discussions with you, and what position you took?

A. I only recollect his telling me that he had endeavored to formulate specifications and claims upon the matter, which he said were not satisfactory to himself. I think he showed them to me, or some of them and that he said that he was in doubt about getting any claims that would stand. Mr. Sawyer and I had furnished him at first, about the middle of October,
3414 1878, with a written statement of the invention. I think that after Mr. Broadnax had formulated some of the claims and specifications, that he and I discussed the matter as to the claims he had prepared, and that he was in doubt about any of them being good, and I thought they were, or some of them were, and that they would stand. I think I prepared, myself, some specifications and claims in regard to the matter after our first discussion of it, after he had prepared provisional or suggestive specifications and claims. I
3415 I think that after that he prepared other specifications and claims which I saw, and I think these papers, including the original papers furnished to Mr. Broadnax by Sawyer and Man, were sent or given to Mr. Sawyer to revise, perhaps more than once, I think the last I saw of them they were with Mr. Sawyer. This occurred in the fall of 1878, and continued on until, perhaps, the 1st of January following, and perhaps later. Now I may not have given the direct order of things done or the discussion had. I cannot recall it to my
3416 memory to speak of it more clearly. I remember stating to Mr. Broadnax that the thing was new and evidently useful, and that it ought to be and I believe it was, patentable. I remember his referring to the matter of charcoal having been used before for electric lighting, and even if it was new it was not necessarily patentable, and any way there was no hurry about it, that we had two years in which to apply for the patent,

3417 and I remember him asking me if anybody else was using it, and if anybody knew of it except ourselves.

3215 R-x Q. Were you aware of the previous use of charcoal or was Mr. Broadnax the first to inform you of it?

A. I was aware of it and I think the first papers I prepared for Mr. Broadnax and gave to him in October, 1878, contained a statement that charcoal had been used for incandescent lighting.

3216 R-x Q. Was there any discussion between you 3418
as to the arch form?

A. Yes, we both thought that was patentable at that time.

3217 R-x Q. Did you both think it was new?

A. I believe we did, but subsequently discovered that an arch form of incandescent conductor, a something approaching that form, made of metal, had been previously used.

3218 R-x Q. Did you discover this before or after the application was filed? 3419

A. I think not till afterwards. I do not wish to be understood that the arch form for a carbon incandescent conductor was not then new, for I believe it was.

3219 R-x Q. Can you not give more clearly than you have the reasons given by Mr. Broadnax for thinking the invention was not patentable, and the reasons you gave him for thinking it was?

A. No, I could not.

3220 R-x Q. Did the company know of these discussions between yourself and Mr. Broadnax? 3420

A. I think the thing was talked of at the board meetings, as all our matters were freely talked of there, but the details of the talk between Mr. Broadnax and me I do not think they knew.

3221 R-x Q. The invention belonged to the company did it not?

A. It did.

3421

3222 R-x Q. Did you treat the subject as though you were dealing with your individual property, or did you consider it your duty to be guided by what the owners of the property might wish, and in order that they might act intelligently keep them fully informed?

A. I don't know what you mean. I was acting for the company in regard to an invention where I was co-inventor; I was President of the company and was acting solely for its interests, and my personal interests through the company. I had no secrets from my
3422 fellow members of the board and did not endeavor to keep anything from them, if that is what you mean, and tried to keep them fully advised of all that was being done.

3223 R-x Q. Did any members of the board know of the discussions between yourself and Mr. Broadnax on the subject matter of this invention, and your requests to him to apply for a patent?

A. I don't know further than that the policy of the company was to get patents for all inventions as fast
3423 as could be done consistently, and that I was instructed to carry out that policy. As to how much of the details of the different patents the different members of the board or any of them knew, I cannot at this length of time state.

3224 R-x Q. Did any members of the board know of Mr. Broadnax's delay in the matter?

A. I do not remember.

3225 R-x Q. What were Mr. Broadnax's habits so far as you knew with reference to promptness and
3424 diligence in attending to the affairs of the company?

A. I do not think we ever made any complaint of Mr. Broadnax in regard to promptness and diligence.

3226 R-x Q. The latter part of your 3015th answer might create the impression that after April, 1879, and before the application was in fact drawn up, Mr. Sawyer refused to sign an application for a patent on the

3425

invention in controversy, such is not the fact, however, as I understand?

A. I intended to be so understood. Mr. Sawyer refused to sign any and all applications for joint inventions of Sawyer and Man. I do not mean to be understood that an application for this particular invention was presented to Mr. Sawyer on behalf of the Electro-Dynamic Light Co. after he refused to sign all and every application for the joint inventions of Sawyer and Man, until the application was prepared which re- 3426
sulted in the patent in suit, which he did sign.

3227 R-x Q. Was an application for a patent in the invention in controversy ever presented to Mr. Sawyer with a request that he execute the same until the application which resulted in the patent in suit was presented to him?

A. Yes, I think so.

3228 R-x Q. When?

A. In the fall of 187[illegible], or early in January, 1879. 3427

3229 R-x Q. By whom?

A. I think the papers were prepared by Mr. Broadnax, and sent or given to Mr. Sawyer to modify and execute them.

3230 R-x Q. And Sawyer refused?

A. Sawyer did not do it.

3231 R-x Q. What reason did he give?

A. I have reference to the papers that I have before referred to in regard to this matter which were sent to Mr. Sawyer or given to him by Mr. Broadnax for correction and amendment. I do not remember talking 3428
with Mr. Sawyer about the matter until some time in February or March, 1879, after these papers were given to him. At that time I went over with Mr. Sawyer the unpatented inventions of Sawyer and Man, among others this subject matter, with a view to get him to sign applications for patents for all of them. He refused to do so, but more subsequently consented to

3429 sign certain applications and assignments and refused to execute any others. The reasons he gave were, as he claimed, that the company was not treating him fairly, and that he was going to sever his connection from the company, and if he could not continue as superintendent that he would do all he could to injure the company, in substance, or at least that he would not do anything to help the company that he was not compelled to.

3430 Adjourned till Wednesday, the 20th inst., at 10½ A. M.

WEDNESDAY, June 20th, 1888.

Met pursuant to adjournment.

Present—Counsel as before, and the examination of Mr. Man was continued as follows:

3431

3232 R-x Q. Do you feel quite positive that an application covering the invention of the patent in suit was prepared by Mr. Broadnax, and sent or brought to Mr. Sawyer for execution?

A. Yes, for examination, correction and execution.

3233 R-x Q. Have you seen the application that was sent him?

A. I think the papers were shown me by Mr. Broadnax before they went to Mr. Sawyer.

3432 3234 R-x Q. Were you satisfied with the application as prepared and sent?

A. I do not remember enough about it to state.

3235 R-x Q. Was the execution in the form for execution and filing?

A. I am not certain.

3236 R-x Q. Had you signed it?

3433

A. No, sir; I don't think I had, or at least I do not remember that I had, but I may have done so.

3237 R-x Q. How do you know such a paper or application was sent or given to Mr. Sawyer for correction and execution?

A. I only know of it as one of the things that I was trying to get done and to get Mr. Sawyer to do, and by another fact as follows: Some little time, a few days as my recollection goes, after the shop at 94 Walker street was closed, and while Mr. Sawyer had an office at the corner of the alley on Walker street, between 3434
Elm and Broadway, Mr. Broadnax at my request went there to see Mr. Sawyer and get him to execute some applications for patents, among others, one for this invention. He came from Mr. Sawyer's place directly to my office, No. 3 Mercer street, and reported to me that Mr. Sawyer refused to execute any paper. The same day, or the next day, I went to see Mr. Sawyer and tried to induce him to execute the papers that Mr. Broadnax had prepared, and he would not. I feel confident that among these papers was an application for 3435
a patent for this invention, and that Mr. Broadnax either took it to him there then, or that Mr. Sawyer had it there then, and the best of my recollection is, that it was another and renewed application than the one or ones previously sent to Mr. Sawyer; but my recollection is not sufficient to swear positively to it. But in confirmation of the matter I remember talking with Mr. Sawyer about this invention when I went to see him after Mr. Broadnax called on him.

3238 R-x Q. Did Mr. Broadnax tell you he had pre- 3436
pared and sent an application for a patent on this invention to Mr. Sawyer in the fall of 1878, or in January, 1879, for correction and execution?

A. I can't undertake to remember the conversation between Mr. Broadnax and myself at this length of time in detail. Whether Mr. Broadnax told me so.

3437 whether I derived the information from Mr. Sawyer or from myself handing him the papers, I cannot say.

3239 R-x Q. Did you bring him the application to sign?

A. I don't know.

3240 R-x Q. Did he ever tell you he had received such an application?

A. He talked with me about the application and its contents, and about Mr. Broadnax's opinion in regard
3438 to patentability.

3241 R-x Q. Did you ever ask him whether he had received such an application?

A. I don't remember.

3242 R-x Q. Did he ever show you any application?

A. As I have said, or intended to say, my best recollections of the matter are that Mr. Sawyer and I looked over the papers together, but whether we did or not, I cannot be certain, or whether we simply talked about and discussed them as a matter known to
3439 both of us.

3243 R-x Q. Have you any distinct recollection of seeing an application for a patent on this invention in Mr. Sawyer's possession?

A. As I have said before, I think and believe that I did, but as remembering a distinct paper in regard to the subject matter which I saw in Mr. Sawyer's possession, I cannot say that I distinctly and positively remember it, but only that I distinctly and positively recollect the preparation of such papers for Mr. Saw-
3440 yer's revision and execution, and recollect talking with him about them after the papers were prepared and he had them.

3244 R-x Q. If it be the fact that an application for a patent on the invention in controversy was prepared and sent to Mr. Sawyer for execution, in the fall of 1878, or in January, 1879, as you think and believe,

3441
can you tell me whether the company was informed of such fact?

A. I, as President of the company and Chairman of its Executive Committee, was informed of the fact, which is, I suppose, information to the company.

3245 R-x Q. Who were the others on the Executive Committee?

A. I think Mr. Sawyer was one; I do not recollect who the other was, but my impression is that Mr.
Lawrence Myers was the other; I should think so, but 3442
I can't recollect.

3246 R-x Q. Who, on the board, if any one, was informed that such application had been prepared and sent to Mr. Sawyer?

A. I don't know, other than I have stated.

3247 R-x Q. Do you remember whether you discussed the specific application with Mr. Sawyer, and whether he refused to sign it?

A. Yes, I remember discussing the application
with Mr. Sawyer and Mr. Broadnax's ideas in regard 3443
to patentability, and I also remember discussing the subject matter with him before the first memorandum was sent to Mr. Broadnax in October, 1878, and afterwards from that time forward until in January, 1879, at several times, and again I remember trying to get him to complete and execute the application for a patent for this invention shortly before we left 94 Walker street, when he positively refused to do so. And again, after Mr. Broadnax visited him at his office, at
the corner of the lane or alleyway and Walker street, 3444
when he positively refused to execute any application. I remember subsequent conversations with him on the subject at different times, up to and shortly before the application was made, which resulted in the patent at which he refused to unite with me in any applications for patents for the benefit of the company.

3248 R-x Q. In your interviews with Mr. Sawyer over

3445 this specific application sent to him for execution between October, 1878, and January, 1879, is it your recollection that he refused to sign the application, or objected to its claims and statements?

A. It is my recollection that he simply neglected the matter and that I urged him to go on and complete it; not that he objected to anything that Mr. Broadnax had done, or any claim that Mr. Broadnax had prepared.

3446 3549 R-x Q. What was it Mr. Sawyer neglected; to sign the application or to criticize and correct it?

A. To revise and sign it.

3250 R-x Q. Did he ever express himself to you as satisfied or dissatisfied with its statement and claims?

A. Well, I don't recollect in those exact terms; I remember his stating, in substance, that he could better or improve the statement or claims, or both, and I remember his discussing with me whether an application simply covering the loop or arch form of the conduc-
3447 tor cut or made to shape and size before carbonization, would not be sufficient without any reference to the character of the carbons, as to which Mr. Broadnax had expressed his doubts as to patentability.

3251 R-x Q. Was any other application covering the invention of the patent in suit prepared than the one which you think was sent to Mr. Sawyer for correction and execution between October, 1878, and January, 1879, until the applicatton which was filed was prepared?

3448 A. I have said that I think Mr. Broadnax prepared a new application which he presented to Mr. Sawyer for execution, when he called upon him at his office, at the corner of Walker street and the alley. Of this I am not positive, but it is the best of my recollection.

3252 R-x Q. When was this?

A. Just after the shops at the corner of Walker and Elm streets were closed. I should say in the month of April, 1879.

3449

3253 R-x Q. Why was this second application prepared?

A. In order to get Mr. Sawyer to execute it.

3254 R-x Q. Was not the first application satisfactory to him or you?

A. I don't know; it was not executed and Mr. Broadnax had several conferences with Mr. Sawyer about the matter before the time of preparing and presenting this last application in the fall of 1878, and early in 1879. 3450

3255 R-x Q. Can you give me no reason why this second application was prepared?

A. I can't recollect the details in regard to it. I assume that it was in order to get Mr. Sawyer to immediately execute and not delay, and perhaps to conform to what Mr. Sawyer's ideas and mine in regard to what the application should be, or what it should contain.

All after first sentence objected to as irresponsive. 3451

A. I know it was done to conform to my desire and request to bring the matter to a close.

3256 R-x Q. How did the second application differ from the first?

A. I don't know that it differed at all, and I don't know but it did.

3257 R-x Q. How do you know Sawyer ever received the second application?

A. From Mr. Broadnax telling me that he presented it to him, and Mr. Sawyer's admission to me that he had done so when I went to see him about it. 3452

3258 R-x Q. Did you ever execute this second application?

A. I do not remember whether I did or not.

3259 R-x Q. Did you ever ask Sawyer to execute it?

A. Yes.

3260 R-x Q. Was any one present?

3453 A. Part of the time during the conference between him and me some one else was present. I think either Mr. Church or Mr. George Sawyer, and part of the time Mr. Sawyer and I were alone at my request.

3261 R-x Q. Did Mr. Sawyer refuse to sign this second application, or object to its claims and statements?

A. He refused to sign any and all applications including the one for this invention.

3262 R-x Q. Did he object to the statement or claims
3454 of this second application?

A. No; he simply objected to it because it was for the benefit of the Electro Dynamic Light Co.

3263 R-x Q. What were the other applications which he objected to sign at this time?

A. I can't recollect what they were; there were several of them.

3264 R-x Q. Mention those you do recollect?

A. I don't recollect any of them to specify them without going through and looking up; I could not
3455 tell what they were.

3265 R-x Q. What would you have to go through and look up?

A. The things that Sawyer and I had done together, which were now patented, and I do not know that I could not sufficiently refresh my recollection to tell what any of them were. I know that included among the papers which Mr. Broadnax then took to him were several assignments and several applications.

3266 R-x Q. Do you remember whether any of the
3456 applications were ever executed and filed?

A. I don't know whether any of them were ever executed, but I cannot be certain.

3267 R-x Q. Were any of the assignments executed?

A. Yes, I think some of the assignments or others for the same invention were subsequently executed by Mr. Sawyer.

3268 R-d Q. Did you inform the company of Mr. Sawyer's refusal? 3457

A. Yes, they all knew it, that is, his refusal to execute any papers for the benefit of the company.

3269 R-x Q. Did they know of his refusal to execute this and other applications for patents?

A. I think so.

3270 R-x Q. How were they informed of it, and who were informed.

A. I informed the board at a board meeting. 3458

3271 R-x Q. Did you explain to the board the several inventions which he had refused to sign applications for?

A. I don't know; I related to the board what had taken place between Mr. Broadnax and Mr. Sawyer, and between Mr. Sawyer and me in a general manner.

3272 R-x Q. Who was present at the board meeting?

A. I cannot recollect.

3273 R-x Q. Mention such as you do recollect? 3459

A. I decline to attempt to recollect it.

3274 R-x Q. Who were the directors of the company at that time?

A. I do not recollect, I can recollect some of them.

3275 R-x Q. Name those you do recollect?

A. Jacob Hays, Lawrence Myers, Wm. H. Hays, I think Mr. Hugh McCulloch, I think Mr. H. L. Judd. I was a director or trustee.

3276 R-x Q. Which of these gentlemen were present.

A. I cannot recollect. 3460

3277 R-x Q. What action did the board take when you informed them of Mr. Sawyer's refusal?

A. If my recollection serves me they sent for Mr. Sawyer.

3278 R-x Q. Did he come?

A. Either then or a subsequent meeting he did.

3279 R-x Q. Did you inform the board of your esti-

3461 mate of the value of the property for which application had been prepared, and which Mr. Sawyer refused to execute?

A. I do not remember.

3280 R-x Q. Did the board or the company take any action to induce or compel Mr. Sawyer to sign the applications?

A. I have said they sent for Mr. Sawyer, and that at that or at a subsequent meeting he was present for the purpose of inducing him to perform his agreements
3462 with the company and execute necessary and proper papers.

3281 R-x Q. Were you present at the meeting referred to?

A. I was.

3282 R-x Q. Who else was there?

A. I do not remember, a quorum of the board.

3283 R-x Q. Mention whom you remember other than Mr. Sawyer and yourself?

3463 A. I cannot remember to particularize.

3284 R-x Q. What took place at this meeting?

A. Generally Mr. Sawyer refused to go on with the company, and said he would make a proposition to the company.

3285 R-x Q. Did he refuse to execute the application?

A. He refused to do anything with the company other than to say that he would make a proposition to them.

3286 R-x Q. Was there such a discussion, or did
3464 you make such explanation as that the board were aware that he refused to execute applications for patents on inventions which the counsel for the company had prepared, and which inventions were the property of the company?

A. I think the board so understood it.

Adjourned till Friday, the 22d inst., at 11 A. M.

3465

FRIDAY, June 22, 1888.

Met.

Present—Counsel as before, and the examination of Mr. Man continued as follows:

3288 R-x Q. What efforts, if any, were subsequently made by yourself or the company to induce Mr. Sawyer to sign the second application?

A. I cannot remember details. I can only say generally that I urged Mr. Sawyer a great many times from this time forward till the application was made 3466
which resulted in the patent, to unite with me in an effort to obtain a patent for the invention, and that Mr. Broadnax, counsel for the company, was directed and requested to apply to him to have the thing done, and I believe did so.

3289 R-x Q. Did the company as a company do anything?

A. I don't remember further than my own action. The company acted through me.

3290 R-x Q. At about what time was this second 3467
application given to Mr. Sawyer to execute?

A. You speak of it as a second application. I think it was, but do not wish to swear to the identity of papers. I have stated that my best recollection was that it was shortly after our leaving 94 Walker street and in the month of April, 1879, but I cannot undertake, after so long a period, to be positively definite as to them. It may have been a little earlier or a little later. I think the expression "Spring of 1879," would 3468
positively cover the time.

3291 R-Q. What is your best recollection of when the meeting was held at which Mr. Sawyer was present?

A. I can only fix it as soon after Mr. Sawyer's refusal to execute any papers in the spring of 1879.

3292 R-x Q. Did Mr. Sawyer persist in his refusal

3469 from the time of the meeting till January, 1880, when the application for the patent was filed?

A. At different times after this and prior to the making of the application which was filed Mr. Sawyer promised me that he would execute an application for this invention, but sent to or applied to personally by Mr. Broadnax, neglected or refused or postponed doing anything about it, and did not so far as I know expect to talk to me. In his talks with me he sometimes refused, sometimes postponed the matter, and sometimes
3470 promised me he would attend to it.

3293 R-x Q. And does this represent his attitude from the time of the meeting till January, 1880.

A. No, not wholly. From some time in September, 1879, up to the making of the application which was filed, he was actively hostile to the Electro-Dynamic Light Co.

3294 R-x Q. Now from the time of the board meeting, at which Sawyer was present, until September, did you inform the board of your and Mr. Broadnax's ef-
3471 forts to get Mr. Sawyer to sign this application, and of your inability to do so?

A. I do not remember.

3295 R-x Q. Did the board consult counsel as to whether they could compel Mr. Sawyer to sign the application, or whether they could file it without his signature?

A. I do not remember.

3296 R-x Q. Did the board do anything to protect
3472 their rights so far as you know?

A. I do not remember what they did about it further than my own efforts in charge of the matter of the company.

3297 R-x Q. Did you inform them of your efforts and their failure?

A. I presume so, I don't remember in regard to it.

3298 R-x Q. You say from September on he was ac-

tively hostile to the company. Did he peremptorily 3473
and positively refuse after September to execute the application?

A. He peremptorily and positively refused to do anything with the company, or for its benefit, unless the company would grant him a license for the use of all the inventions, which the company refused to do.

3298 R-x Q. Did this refusal include the refusal to execute this application?

A. The refusal included every invention. 3474

3300 R-x Q. Do you mean to answer "yes" to my question?

A. In that way, yes.

3301 R-x Q. Do you remember whether he was asked to sign this application after September?

A. I do not remember as a specific thing, until some short time before the application was filed.

3302 R-x Q. Were the company aware of his refusal to do anything?

A. I think they were. 3475

3303 R-x Q. Did the company take any steps to secure their rights in this matter after September?

A. Yes.

3304 R-x Q. What did they do?

A. They counseled with Mr. Broadnax in regard to the matter, as to what their rights were in a general manner, and what was best to be done under the circumstances.

3305 R-x Q. Did he advise the company?

A. I do not remember what his advice was. 3476

3306 R-x Q. Between October, 1878 and January, 1880, Sawyer did at different times execute applications and assignments to the company, did he not?

A. Yes.

3307 R-x Q. It appears from the exhibits in the case printed in the interference record, that numerous assignment were executed by Mr. Sawyer transferring

3477
property to the Electro-Dynamic Light Co. from October, 1878, to August, 1879, what explanation have you to offer for his executing these papers; and not executing the application to which you have referred?

A. I think I have already explained that fully.

3308 R-x Q. Perhaps so, but please do so again?

A. I have explained the delays in getting Mr. Sawyer to sign an application for this patent up to the time of the breaking up of the shop at 94 Walker street, that for some time before breaking up the shop the
3478 company was dissatisfied with Mr. Sawyer and his management as superintendent which Mr. Sawyer knew, and that Mr. Sawyer was averse to making applications during that time, and delayed and put them off, and that after Mr. Sawyer's discharge, as superintendent, and the breaking up of the shop, he only signed applications and assignments by special agreement or arrangement with him in each particular case by which he thought he was obtaining some personal advantage, or under which he was unable to get money
3479 or dispose of stock of the company which he held.

3309 R-x Q. On December 9, 1878, Sawyer joined in an assignment to the company of several applications for patents on his sole inventions. What special consideration or inducement was given him for this?

A. I did not state that there was any. It was done under his general agreement.

3410 R-x Q. On December 9, 1878, Sawyer joined in an assignment to the company of certain joint applications signed by Sawyer and Man. Was any spe-
3480 cial consideration given him for this?

A. I have not stated that there was any special inducement for any of the assignments or applications made by him until his discharge as superintendent.

3311 R-x Q. On July 30, 1879, Sawyer executed an assignment to the company upon application for an electric lamp filed April 3d, 1879. What special inducement was offerred or given him for this?

A. I cannot remember the details of the arrangements by which he was induced, from time to time, to 3481
sign applications or assignments after his discharge as superintendent. I can only say generally that at the time the arrangement was made with the Messrs. Wallace, under which Sawyer received a large consideration in money and otherwise, he agreed in substance to execute such papers, assignments and applications as the counsel to the company advised were necessary and proper, part of which he performed, as in the exe- 3482
cution of the papers to which you refer, but frequently after repeated attempts to get him to do so, and by pushing him to perform what he had agreed and sometimes he was only induced to do so by finding for him purchasers of the stock of the company which he held, or by making loans to him. I cannot remember the details of the inducements to him in any particular case.

3312 R-x Q. You do not remember then what, if any special inducement or consideration, was given to him 3483
for the execution of the paper referred to?

A. No.

3313 R-x Q. On the 3d of February, 1879, Sawyer and Man executed the assignment of a number of patents to the company, was any special inducement given to him for the execution of this paper?

A. I have already stated that I do not know of any special inducement to him to sign papers other than his general agreement prior to his discharge as superintendent. 3484

3314 R-x Q. On May 21st, 1879, Sawyer executed a general release in favor of yourself and others. What special inducement or consideration was given him for this?

A. I answer as before that I cannot recollect the inducement in any particular case. I remember it was given in connection with the arrangements made with the Messrs. Wallace.

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3315 R-x Q. On July 30, 1879, Sawyer executed an assignment of an application for a sole invention of his electric lamps. What special consideration or inducement was offered him for this?

A. I answer as before, that I do not remember the special inducement in any particular case.

3316 R-x Q Was Sawyer ever offered any special inducement or consideration to sign the applications which was prepared by Mr. Broadnax covering the
3486 patent in suit ?

A. I don't remember.

3317 R-x Q. Who conducted the interviews or negotiations with Mr. Sawyer with reference to the executions of these applications and assignments ?

A. I some; Mr. Broadnax some; I think Mr. Jacob Hays some; I have reference to the papers made after his discharge as superintendent.

3318 R-x Q. What explanation have you to offer for the sending of Mr. Sawyer to Ansonia by the company
3487 after his neglect or refusal to sign an application for a patent on an invention belonging to the company?

A. I do not think it needs explanation, and I do not desire to make any. Do you desire one?

3319 R-x Q. I would not have asked the question if I had not.

A. I don't desire to make any explanation.

3320 R-x Q. When the application for the patent in suit was filed, was either Mr. Cheever or Mr. Baldwin informed that a prior application had been prepared?

3488 A. I don't remember.

3321 R-x Q. You never told them?

A. I don't remember whether I did or not.

3322 R-x Q. If the subject of this invention had been one of so much discussion between yourself and Mr. Broadnax, would it not have been a very natural thing to have done?

A. I don't know.

3489

3323 R-x Q. From the record in the interference between Weston and Sawyer-Man it appears that the minute book of the Electro-Dynamic Light Co., was in your possession on December 13, 1882; was it then in your possession ?

A. No, I think not, further than it was handed to me to refer to extracts from the minutes copied on pages 69 and 70 of the interference (printed) record of Edward Weston against Sawyer and Man.

3324 R-x Q. Where was that testimony given? 3490

A. If I recollect rightly, at my office, No. 3 Mercer street.

3325 R-x Q. What is your recollection as to the custody of the book: was it in your possession, or was it brought there?

A. It is my recollection that it was brought there by Mr. Broadnax.

3326 R-x Q. Did he leave it there or take it away?

A. I have no recollection. 3491

3327 R-x Q. Did you ever see the minute book after the occasion referred to?

A. I don't recollect.

3328 R-x Q. Did you ever try to find it?

A. Yes.

3329 R-x Q. Did you find it?

A. No, I do not think I did, but perhaps I did. I recollect trying to find it and not being able to do so. I mean that I don't know, but that after I saw it at my office I saw it again, and I don't know that I did, but at a subsequent period I searched thoroughly for it 3492
and could not find it.

3330 R-x Q. The extract from the minutes of May 20 speaks of a "royalty of three dollars a lamp for such lamps as they should put up." Does this refresh your recollection as to whether the royalty was to be three dollars a lamp whether such lamps were original or renewal lamps, or whether the royalty was to be

3493

paid on original lamps, and that renewals were not to be subject to royalty?

A. No, because at the same meeting as appears by the extract from the minutes, a committee was appointed to draw up the details and prepare the license. In regard to this whole matter permit me to say that it is my impression that the royalty was applicable only to the lamps as first put up, and not to renewal lamps, but in the absence of the agreement or license I do not wish to be understood as swearing positively that
3494 such was the fact.

3331 R-x Q. From the minutes of Nov. 25th it would seem that an agreement had been made with Mr. Wallace, and that the company was directed to execute it. Was a written agreement ever made?

A. I think so, but I don't know where it is. It was cancelled afterwards.

3332 R-x Q. Do you remember how the business was to be done under this agreement?

A. The Messrs. Wallace were to manufacture and
3495 sell under all the patents of the company and the inventions belonging to the company, all the different apparatus, and were to pay for their exclusive license to do so a royalty of three dollars per lamp as compensation for the use of all the inventions; and my impression is, but I cannot swear positively to the fact, that the royalty was limited to the lamps as first set up or installed, and not to renewal lamps or plants which they had previously set up and supplied with lamps. They were to sell to the public and make re-
3496 ports to the Electro-Dynamic Light Co.

Adjourned till Monday, the 25th inst., at 11 A. M.

3497

NEW YORK, June 25th, 1888.

Met pursuant to adjournment.

Present—Counsel as before, and the examination of Mr. Man was continued as follows:

3333 R-x Q. Referring to your 3018th answer, wherein you say,

> "We (Sawyer and I) always cautioned our workmen not to say anything about what we were doing," 3498

which of your workmen knew of this invention at the time to which you refer, and was so cautioned by you?

A. We cautioned Mr. William Sawyer, Mr. George Sawyer and Mr. E. L. Myers and the others, from time to time.

3334 R-x Q. Please mention the names of the others to whom you refer.

A. There was a Mr. Keating and Mr. Sharp and the people who did work for us outside. Mr. Judd's folks, Mr. Lothrop and Mr. Edsall, who knew most about 3499
our work in Judd's shops. I do not remember the names of others, and I do not mean to say that all those I have named knew of this invention, though they may have done so, except Mr. Keating.

3335 R-x Q. Who of Judd's folks do you think knew of it?

A. Edsall and Lothrop, if they did know about it, and Mr. H. L. Judd himself, possibly.

3336 R-x Q. Are Edsall and Lothrop with Judd now? 3500

A. I think they are; I don't know.

3337 R-x Q. What were they employed as?

A. Foreman and superintendent.

3338 R-x Q. At his factory in Brooklyn?

A. Yes, in State street, Brooklyn.

3339 R-x Q. Do you remember their first names?

3501 A. I think Mr. Edsall's name was William; I do not remember Mr. Lothrop's.

3340 x-R Q. In the answer above referred to you say:

> "We did explain the matter to our friends and some of the stockholders of the Electro Dynamic Light Co."

Mention the friends to whom you explained it?

A. I cannot, except as to some few.

3502 3341 R-x Q. Mention the few?

A. I explained many of our matters to Mr. Wm. Halley and to Mr. James M. Jackson who were in the office with me at No. 3 Mercer street. I frequently explained matters to different members of the board of trustees of the Electro Dynamic Light Co. I remember explaining it to Mr. E. D. Griswold, a neighbor of mine, and to Mr. Allen, who was in the same office with Mr. Griswold. I remember explaining it to a neighbor, Mr. Rowe, of Brooklyn, Edward Rowe.

3503 3342 R-x Q. Was this all before the application was filed?

A. Yes, I think so; all of it.

3343 R-x Q. Do you mean to be understood by 3339 answer that the matter of the invention in controversy was explained to the gentlemen you there mentioned?

A. Yes, or some of them.

3344 R-x Q. Which of them.

A. I think it probable that it was explained to all of them, but I cannot be certain at this length of time. I
3504 explained our inventions generally to them, and therefore think this matter was included. It would be proper to say that I omitted Mr. Broadnax, counsel for the company, to whom very full explanations were given both by myself and Mr. Sawyer.

3345 R-x Q. Were Mr. Alley and Mr. Jackson in your employ?

A. They were my assistants in the Lorillard office.

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3346 R-x Q. What was Mr. Griswold's business?

A. He is a manufacturer of cotton goods in Massachusetts. He lives in Brooklyn.

3347 R-x Q. What is Mr. Rowe's business?

A. I don't know that he has any business now. He was engaged in the straw hat business, an importer.

3348 R-x Q. To what stockholders of the Electro Dynamic Light Company was the matter explained?

A. I don't know; I should think to nearly all of them that I met. They frequently talked to me about 3506
our inventions.

3349 R-x Q. If you were desirous of keeping the matter secret why did you explain it to the gentlemen named, if in fact you did do so?

A. I cannot remember the reasons. It was done in confidence with them.

Adjourned till Thursday the 28th inst., at 11 A. M.

3507

Met pursuant to adjournment.

Present—Counsel for cmoplainant, and witness and counsel for defendant not appearing, adjourned to Monday, July 2, 1888, at 1 o'clock, P. M.

July 2, 1888.

Met pursuant to adjournment, and counsel for de- 3508
fendant not appearing, adjourned to July 3, 1888, at 1 o'clock P. M.

New York, July 3, 1888.

Met pursuant to adjournment.

Present—Counsel as before, and the examination of Mr. Man continued as follows:

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3318 R-x Q. If, as you say, applications covering the inventions in controversy were prepared and the subject of their preparation and execution was a matter of the extent of discussion your testimony would indicate, what explanation have you to make of the fact that in the interference between Sawyer-Man and Edison no reference was made or testimony produced as to these several things?

> Objected to as immaterial and for the
> 3510 further reason as not cross-examination, as there was no question of laches raised or inquired into or even alleged.

A. I do not know that the matter needs explanation. So far as counsel and others are concerned, I am not in position to make explanation for them. So far as I myself am concerned, if my testimony in the interference does not refer to this subject matter, it was because my attention was not called to it, and I was
3511 not questioned in regard to it that I recollect.

3349 R-x Q. Do you remember in whose possession you last saw the memoranda in relation to this application or the application themselves?

A. In Broadnax, the counsel's hands, or Mr. Sawyer, I do not recollect which.

3350 R-x Q. You speak of selling some of the machinery which at one time belonged to the Electric Dynamic Light Co. Do you remember to whom you sold it?

3512 A. I sold a lathe, lathe tools and other tools to a Mr. Bigbee in Brooklyn. I sold a lot of stop-cocks and chemical apparatus, retorts, receivers and I don't know what, all to a dealer in such things. I don't know what his name was. He came to the place in Pacific street, where they were, and selected them out. I sold several parcels to different old material men. I don't know their names. I sold some gearing and counter

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shafts to machinery men in Centre street. I don't recollect who else I sold to at different times, and I don't recollect the names of any of the parties, except Mr. Bigbee.

3351 R-x Q. You have mentioned the names of several gentlemen to whom you believed you explained, or who were informed in other ways of the making of the invention in controversy prior to the application. Why were they not called in the interference?

A. I don't know. I suppose because their testimony 3514
was not necessary or not thought to be so by counsel managing the case.

3352 R-x Q. Did the Eastern Electric Manufacturing Company ever have a bank account?

A. I don't know.

3353 R-x Q. Do you know where the books of the Eastern Electric Light Co. are, or any of them?

A. No.

RE-CROSS-EXAMINATION CLOSED. 3515

QUESTION BY MR. BROADNAX, COMPLAINANT'S COUNSEL.

3354 R-r-d Q. In answer to re-cross 3318, and also in answer to question 3319, you stated that you did not desire to make any explanation of the sending of Mr. Sawyer to Ansonia by the Electro Dynamic Light Co. after his neglect or refusal to sign an application 3516
for a patent on an invention belonging to the company. Please to state what your recollection is of the reason why Mr. Sawyer was sent to Ansonia after such a refusal or neglect to sign such application.

A. As I stated before, I do not desire to go into that matter, because I do not consider it necessary to the case; I have nothing to conceal in regard to it.

3517
Do you consider it necessary that I should make answer. If you do, I will do so.

3355 R-r-d Q. Of course I want an answer, or an explanation, if there be one?

A. I have already testified that the company had refused to go on with Mr. Sawyer as superintendent of its workshops, and that Mr. Sawyer insisted upon it that he should be such superintendent or the work should not go on. Things had come to such a pass
3518 that there was violent antagonism between the company and Mr. Sawyer; on his part, at least. There was nobody but myself and in part, Mr. E. L. Myers, a very young man and experienced in manufacturing, who knew about the work of the company; I could not give my attention to it, and the only remedy against Mr. Sawyer, on the part of the company, would be litigation, which was advised against by the counsel for the company. Under these circumstances a concession was made on the part of the company to Mr. Sawyer,
3519 and the Messrs. Wallace were brought in to do the manufacturing, in order that the manufacturing might go on, and Mr. Sawyer was paid to give advice and instruction at Mr. Wallace's place in Ansonia, but not as superintendent of the manufacture.

3356 R-r-d Q. Do you mean by your last answer that Mr. Sawyer was sent to Ansonia at that time for the purpose of conciliating him and to get him to remain sober and work diligently in harmony with the company's interests.

3520 Objected to as leading and calling for a conclusion.

A. I mean that the arrangement was made to conciliate Mr. Sawyer, and it was only entered into on his promise and agreement with the company to remain sober, and behave himself in other respects and work diligently and in all ways to promote the interests of the company.

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3357 R-r-d Q. State whether or not Mr. Sawyer carried out the agreement referred to in your last answer?

A. He did not, as I have stated in testimony before.

QUESTIONS BY DEFENDANT'S COUNSEL.
MR. TOMLINSON.

3358 R-d-x Q. When this agreement was made was 3522
Sawyer conciliated and friendly?

A. For a little and until the matter was closed, and until he got the money and other considerations going to him under the agreement.

3359 R-d-x Q. While in this mood was he asked to sign the application?

A. I don't knew.

3360 R-r-x Q What was the necessity for conciliating Mr. Sawyer?

A. I have already stated that; to avoid litigation and 3523
prevent antagonism on his part, and to get him to work for the company's interests.

3361 R-r-x Q. Why, when he was concilated, was he not requested to sign this application?

A. I think he was, I do not know. I think he was by the counsel for the company, Mr. Broadnax, and I, myself, personally urged him to go on and complete the applications for patents for the unpatented inven-
tions of himself and me together, including this, not 3524
specifically, but generally.

3362 R-r-x Q. Did he refuse when Mr. Broadnax made the request?

A. I only know from the report sent to me and made to me by Mr. Broadnax that he did not do it, and Mr. Broadnax could not get him to do it.

3363 R-r-x Q. Was this the first indication that you

3525 had of Sawyer's unfriendliness after being conciliated by the agreement?

A. I don't remember. I do not mean to be understood in my answer before this that Mr. Sawyer did not sign any applications or papers after this, but that such was the complaint made to me by Mr. Broadnax, coupled with a request that I should see Mr. Sawyer about matter, which I did.

3364 R-r-x Q. If the fact be that Mr. Sawyer was placated by the agreement temporarily, and signed
3526 papers, while so placated, in the company's interests, what is your explanation of this application not having been signed with the others?

A. Mr. Sawyer only signed a few of the papers that were sent to him, and not all, but neglected or postponed them and did not execute them, and sometimes refused absolutely, as I was informed by Mr. Broadnax. The matter of this invention was one that he did not execute at that time.

3365 R-r-x Q. But why can you give me no explana-
3527 tion as to this specific application?

A. Not more than others.

3366 R-r-x Q. But you give me no explanation as to the others. What was the reason for not signing the others; whatever you mean by "others?"

A. Much of the time Mr. Sawyer was not in condition to do any business. Further, I believe that Mr. Sawyer was actuated by a motive to retain a hold upon the company by not executing the papers which were sent to him and which he was requested to execute,
3528 in the hope that he could get further consideration for doing so, either by being retained in the payment of the company, or by getting further consideration for everything that he did for the company.

3367 R-r-x Q. I do not understand from your answers the cause of the neglect or refusal of Sawyer to sign an application for this invention while he was con-

ciliated by this agreement, nor do I understand whether 3529
you mean to say whether he was requested to do so. The exhibits in this case show that all the patents of Sawyer and Man were assigned by him to the company, that he assigned one or two patents and applications on his separate inventions and executed a general release to you and to the company. When I ask you for an explanation of his not signing an application for this invention, you refer in general terms to his neglect or refusal to sign papers but do not give me any ex- 3530
planation why this specific paper was not signed?

A. Not as distinguished from the others?

ALBON MAN.

Sworn to me before this 12th day of July, A. D., 1888.

WM. T. FARNHAM,
Notary Public.

County and State of New York. 3531

Complainant's counsel here gives notice to defendant's counsel that he now closes his affirmative proofs in this case but it is agreed between counsel, that if any merely formal matter has been inadvertently omitted which may be necessary or proper to complete the 3532
matter of the foregoing deposition, such as the filling in of dates, marking exhibits or offering as exhibits matters or papers which have been referred to, and the like, either party may put in such formal matters; and it is further agreed that no objection shall be taken to any of the proofs heretofore put in

3533 by complainant in this cause, upon the ground that it was not put in within the time limited by the rules of the Court ; nor shall any objection be taken to any such proofs upon the ground that it was not put in and certified by one of the standing Examiners of the Court, but the whole of the foregoing deposition may be sworn to and certified before William T. Farnham, the Notary Public, by whom the deposition was actually taken, and such de-
3534 position and proof accompanying and making part of the same shall stand in the case the same to all intents and purposes, and have the same force and effect as if they had been taken before, sworn by and certified to by Timothy Griffiths, Esq., who was originally selected as the Examiner, before whom such proofs were to be taken.

Witnesses :

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JOHN C. TOMLINSON, for Defendant.

BROADNAX & BULL, for Complainant.

July 12th, 1888.

3368 Q. I place in your hands a paper. Please to
3536 examine it and state what it is ?

A. It is a paper belonging to the Electro-Dynamic Light Co., dated January 9th, 1880, signed by Charles A. Cheever, witnessed by W. K. Applebaugh and W. D. Baldwin, and is an agreement made by and between the Electro-Dynamic Light Co. and Charles A. Cheever, of the City of New York.

3369 Q. Is this the same agreement referred to in

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your New York deposition relating to the provisional sale of the invention of the patent in suit, or a part thereof, to Charles A. Cheever ?

A. It is.

3370 Q. This is the original agreement, as I understand you, entered into by Mr. Cheever with the Electro-Dynamic Light Co. ?

A. It is. I desire to state in this connection that from about 1881 or 1882, or prior thereto, I have not seen or had access to this paper until within the last 3538
few days, or at least have not seen it or been able to do so, although I inquired for it.

Paper offered in evidence and marked "Complainant's Exhibit, Cheever Agreement, March 27, 1889.'

3371 Q. What, if any, explanation do you wish to make of the paper which you have examined and identified as the agreement between the Electro-Dynamic 3539
Light Co. and Charles A. Cheever ?

A. In the New York case in answer to cross-question 318, at page 407 of my printed testimony, the following question was asked me :

"What is your recollection as to whether under the arrangement with Mr. Cheever, the Electro-Dynamic Light Co. was to have the use of the invention ?"

My answer was: 3540

"My recollection of the matter is that the Electro-Dynamic Light Co. were to have the right to use the invention or some part of it by an understanding with Mr Cheever."

To the next cross-question, No. 318*b*, (318*b*), same page I was asked :

3541

"Was this expressed in the written agreement?

To this question I answered:

"My impression is it was not. My recollection is not clear about it though."

The production of the written agreement with Mr. Cheever refreshes my recollection upon this subject,
3542 and I now remember that it was the intention to sell to Mr. Cheever only the arched horseshoe or V-shaped incandescent conductor of whatever carbon it might be made, and not the conductor or other forms which does not comprise the whole invention, but excludes, or was intended to exclude conductors of other shapes of whatever carbon they might be formed or made.

3375 Q. I place in your hands Defendant's Exhibit Baldwin-Wallace letter, January 8, 1880. Please to refer to the last clause of that letter, and explain what
3543 it means as you understand it?

A. The purpose of this letter was to make it perfectly plain that the Electro-Dynamic Light Co. controlled the application for a patent made in its behalf by an attorney, the writer of the letter, selected by Mr. Cheever, and to make it clear that Mr. Cheever's interest had reference only to the arched or pointed form, V-shaped carbon conductor.

3373 Q. Do you mean without reference to the kind of carbon of which the conductor might be made?
3544 A. I do.

3374 Q. What was your understanding as to the novelty of the illuminating conductor being made in the form of an arch, or loop, or V-shape at the time this agreement with Cheever was made, irrespective of the kinds of carbon of which that conductor might be made?

A. At that time we deemed this form of incandes-

3545

cent conductor novel and original with us, and believed that we were the first to make incandescent conductors for electric lamps of those forms.

3375 Q. Do you mean carbon incandescing conductors?

A. I do, and not only carbon but all incandescing conductors of that form I think, but certainly those made of carbon.

3376 Q. And was it that form of carbon conductor that you negotiated or that the Electro-Dynamic 3546
Light Co. negotiated to sell to Mr. Cheever?

A. It was conductors of those forms, as they are mentioned in the contract, and those forms only.

3377 Q. Please to examine the paper now handed you, and state what it is?

A. It is a copy of the Scientific American, a paper published in New York, dated December 7, 1878, containing a printed article and illustrations, headed, "The Sawyer-Man Electric lamp."

3378 Q. How recently have you read the article men- 3547
tioned by you, published in that paper, called the "Sawyer-Man Electric Lamp?"

A. I have not read it very recently. I will read it now.

Adjourned till 2 P. M.

Resumed after adjournment. 3548

Witness continues:

I have now read the article referred to.

3379 Q. State, if you please, whether you find any reference in that article to the making of the illuminating conductor of carbonized, fibrous or textile material?

A. I see no reference in this article to the carbon

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conductor, as to how it was made or what it was made of.

3380 Q: State, if you know, why there was no reference made in that article to the making of the illuminating conductor for your lamps, of carbonized, fibrous or textile material?

A. Because it had not been patented or an application filed for it up to that time.

3550 3381 Q. Was it or not the purpose of yourself and
Mr. Sawyer to keep all knowledge of that invention or discovery from the public before an application for a patent for it had been filed?

A. It was, not only in regard to this but also in regard to other things and other kinds of carbon, but we did disclose these things to a few people in confidence, and we could not keep it entirely from the knowledge of our workmen, or some of them.

Said Scientific American is offered in evi-
3551 dence (proof of publication being waived by
defendant's counsel) and the same is marked "Complainant's Exhibit, Scientific American Article, produced by Albon Man, March 27, 1889. W. T. F., S. E.

3382 Q. Have you recently measured the size of the rooms occupied by the Electro-Dynamic Light Co. as a shop on the corner of Walker and Elm streets?

A. I have.

3552 3388 Q. Please to give the general dimensions of
those rooms, and please to make a diagram of them, marking the dimensions on the diagram?

(Witness makes a diagram and hands it to Mr. Broadnax.)

3384 Q. Please to describe the diagram you have made, giving the dimensions marked on it?

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A. The entrance was on Walker street, at the southwest corner of the building. The building stands on the northwest corner of Walker and Elm streets. A hall seven or eight feet wide, with a staircase, leads to the second story, extending back from Walker street, according to my measurement, seventeen feet six inches. From this hall in the second story a door led into the front room on the corner of Walker and Elm streets. Another door opened from the hall into our engine room. The front room, according to my measurement,
was seventeen feet six inches deep on Elm street, and 3554
eighteen feet six inches wide on Walker street, with two windows on Walker street and one on Elm street. At the southwest corner of this room were two doors, together five feet wide, opening on a hatchway extending from the ground floor to the top of the building. At the northwest corner of this room a door opened into the back room, which, according to my measurement, was twenty-two feet six inches in length on Elm street, and about nineteen feet deep. Opening
out of the back room, and near to the door from the 3555
front room, was an open space about three and a-half or four feet wide leading into the engine room, which is seven feet wide and about seventeen feet long. At the north end of the engine room was the water closet and sink. At the northwest corner of the building is a light-hole, a shaft about four feet square, extending from the ground floor to the roof. There were two windows in the back room looking on Elm street, a brick partition wall between the back room and the
engine room, a brick partition wall between the engine 3556
room and the hall, and a simple board, wooden partition between the hall and the front room. The dimensions I have given are interior dimensions and are substantially accurate, but not positively so, as I had to take them with a tape line without assistance. The height of the rooms is about twelve feet to twelve feet six inches. The height from the first floor to the roof

3557 in the light-hole at the northwest corner is about thirty-nine feet.

3385 Q. These rooms of which you have made a diagram and given a description, as I understand you, occupied the whole of the second floor of the building?

A. The rooms and the hallway did, except the hoistway at the front end of the hallway on Walker street, about five by seven or eight.

3386 Q. Do the description and diagram you have
3558 made and given represent the rooms at the time they were occupied by the Electro-Dynamic Light Co.?

A. They do.

3387 Q. What does the circular figure represent in the side room?

A. The engine and boiler.

3388 Q. And this engine and boiler, as I understand the diagram, were accessible from the hall leading to the stairway and also through the door or passageway from the back room near the partition wall, between
3559 the two rooms?

A. Yes.

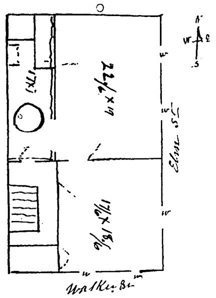
> Diagram offered in evidence as part of the witness' deposition and the same is marked "Complainant's Exhibit Man's Diagram Walker and Elm Shop, March 27, 1887."

3389 Q. Have you also measured the size of the shop occupied by you and Mr. Sawyer at 43 Centre
3560 street. If so, please to make a diagram marking the dimensions thereon?

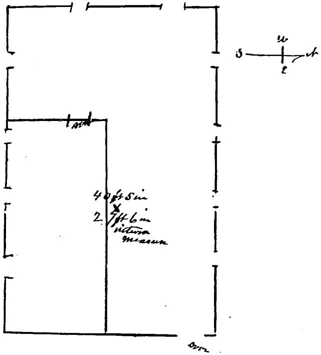
A. I have made such a diagram and now produce it.

3390 Q. Please to describe the diagram produced by you, giving its several dimensions?

A. The entrance to the premises was through a passageway from Centre street, and the premises were in a rear building or rear part of a building up two flights of stairs, I think. The entrance to the room



Consolidated E L Co
vs
McKeesport L Co
Complainant's Exhibit
Man's diagram Walker & Elm Shop
March 27, 1887.
W.H.F.
S.E.



Cons E L Co
vs
McKeesport L Co
Complainant's Exhibit
Man's diagram Centre
Street Shop March
27 1889 W. F. J.
S. E.

— 3561
was at its northeast corner. There were windows on the northwest and south sides of the room. The room is forty feet five inches long, east and west, and twenty-seven feet six inches wide, interior measurement. I should think it was ten or twelve feet high. This room was divided by a partition, partly of canvas and partly of boards, into two rooms, the smaller one in the southeast corner, being about twelve feet wide, north and south, and twenty feet long, east and west.
I have placed the window openings in the diagram 3562
from recollection only, and they are only substantially correct as to position and number. That is, there were several on each side of the room and several at the west end of the room.

Diagram offered in evidence and marked "Complainant's Exhibit Man's Diagram Centre Street Shop, March 27, 1889."

I had not seen this place until to-day since 1878. 3563
The diagram represents it as it was then.

3391 Q. In addition to the electric lamps made by the Electro Dynamic Light Co., at the shop corner of Elm and Walker streets, what other and additional apparatus or parts of apparatus were made there as parts of your system of electric lighting?

A. Very little manufacturing, except of carbons and models and patterns, was done at No. 94 Walker street. The several parts of lamps, excepting carbon conductors, were divided up and the separate pieces
were sent to different shops and mechanics to be man- 3564
ufactured and finished. The carbons were made at 97 Walker street, except the holders made of carbon, which were sent out with the patterns to be made. The several parts were returned by the mechanics who manufactured them, finished and ready to be assembled and set up, to our place, 94 Walker street. In addition to lamps, we had manufac-

3565

tured in the same manner switches, resistances, parts of a regulator, parts of, or a complete meter, brackets, and I don't know what all. Mr. Sawyer also started on his own account the manufacture of a dynamo, by H. L. Judd & Co., of Brooklyn, which was subsequently completed and paid for by the Electro-Dynamic Light Co., and the machine was sent to 94 Walker street while we were there, and tested and tried, and subsequently sent back to Mr. Judd in Brooklyn. I had intended in my correction of testimony in the
3566 New York case given this morning, to have mentioned this dynamo, as I was very thoroughly cross-examined in regard to dynamos in the New York case, and I failed to recall this one, and it is only within the last week or ten days and since I testified in the New York case, that it has come to my recollection.

While I am on the question of corrections I understand the testimony in the interference case with Edison is introduced in this case in some way, and in the
3567 printed testimony in the interference case and perhaps in the record I am made to say "We went to 43 Centre street on the Six or Seventh of February, 1878. Of this there can be no doubt," or in substance this. The word February is a mistake, and should read March; whether it was a *lapus lingua* of mine, or an error in taking down or printing the testimony, I do not know. The fact is, we went to 43 Centre street on the 6th or 7th of March, 1878. I well knew that fact and intended to so testify. I had at one time a letter from Mr. Sawyer, dated March 7th, 1878, showing the time
3568 of our going there and which is now handed to me by counsel for complainant, and I now produce it.

3392 Q. Is this letter, referred to by you, in the handwriting of Mr. Sawyer, and was it received by you at about the time of its date?

A. It is, and it was received by me on the date of its date. In it I was asked to come to the place, 43

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Centre street, that day, and did go there that day, though I think I also went there the day previous.

> Letter offered in evidence and marked "Complainant's Exhibit, Sawyer's Letter, dated March 7th, 1878. March 27, 1889."

3393 Q. Referring now to the dynamo mentioned by you in the previous answer as having been designed by Sawyer and made in whole or in part by Mr. Judd, is 3570
that the same dynamo that is described and claimed in Letters Patent of the United States granted to William E. Sawyer, February 8th, 1881?

A. It is substantially the same thing.

> Patent offered in evidence and marked "Complainant's Exhibit, Sawyer's Dynamo Machine patent of February 8, 1881. March 27, 1889."

Adjourned till Thursday, the 28th inst., at 11 A. M 3571

THURSDAY, March 28, 1889.

Met pursuant to adjounment.

Present—Amos Broadnax, Esq., for Complainant and Grosvenor P. Lowrey and Walter K. Griffin, Esqrs., for Defendant.

3394 Q. I place in your hands Letters Patent of the 3572
United States granted to William E. Sawyer and Albon Man, No. 229,476 for improvement in electric switches dated June 29, 1880. Please to state whether the switch illustrated and described in that patent was made or caused to be made by you and Mr. Sawyer for the Electro-Dynamic Light Co. while your shops were at the corner of Walker and Elm streets?

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A. A large number of these switches, some of plaster of Paris and more of soap-stone, were made for us while we were at 94 Walker street, and the parts sent to us at that place and assembled by ourselves or our workmen, and I have a large number of them now, and their parts.

Patent offered in evidence and marked "Complainant's Exhibit, Sawyer-Man Soapstone Switch Patent, March 28, 1889."

3574

3395 Q. I place in your hands Letters Patent of the United States: 210,152, dated November 19, 1878, granted to yourself and William E. Sawyer, for improvement in switches for electric lights. Please to state whether you and Mr. Sawyer made or caused to be made such switches at the shop of the Electro-Dynamic Light Co. at the corner of Walker and Elm streets, New York?

A. We had manufactured the parts for a large num-
3575 ber of switches and safety devices shown in the illustrationof this patent, and set up a considerable number of them, I don't know how many, at our place, 94 Walker street, corner of Elm street, and I have some of the completed switches and many of the parts not set up now. We also made or caused to be made, a large number of the switches embodying the idea of this patent, using circular instead of sliding movement, as embodied in a switch that I now produce, of which a considerable number were set up, I don't know how
3576 many, while we were at 94 Walker street, and of which I have a considerable number completed still, and the parts for many more. The switch produced has never been put to actual use, but was made in its different parts at different places by special tools and machinery adapted for its manufacture.

Patent offered in evidence, and marked

3577

"Complainant's Exhibit, Sawyer-Man Switch Patent. 210,152, March 28th, 1889."

Switch produced by the witness also offered in evidence, and marked "Complainant's Exhibit, Sawyer-Man Switch, produced by Albon Man, March 28th, 1889.

3396 Q. I place in your hands re-issued Letters Patent, No. 10,18:, dated June 6, 1882, originally patented June 25, 1878, to yourself and William E. Sawyer 3578
for electric lighting system. Please to state whether the apparatus described and illustrated in that patent were made and used or caused to be made and used by you and Mr. Sawyer at the shop of the Electro-Dynamic Light Co., corner Walker and Elm streets, in this city?

A. They were.

3397 Q. I place in your hands Letters Patent of the United States granted to yourself and William E. Sawyer, No. 205,305, dated June 25, 1878, for improvement 3579
in regulators for electric lights. Please to state whether the apparatus described and illustrated in this patent was made or caused to be made by you and Mr. Sawyer and used at the shop of the Electro-Dynamic Light Co., corner of Walker and Elm streets, in this city?

A. Before geing to the corner of Walker and Elm streets, accordihg to the best of my recollection, patterns for the several parts of the apparatus described in this patent were made by us, and the parts ordered. 3580
They, or some of them, were set up while we were at 94, Walker street. Whether any completed regulators were made, I do not recollect, and believe that at most only one was tried experimentally, but not in connection with our system of electric lights which we had set up for exhibition. My impression is that the parts for several regulators were assembled at the place, 94

3581
Walker street, according to the plan of that patent, but not put to actual use. One regulator we ran experimentally complete, and I remember the parts shown in Fig. 3, as a whole, being set up and run there, and some of the parts separately from the rest.

Patent offered in evidence, and marked "Complainant's Exhibit, Sawyer-Man Regulator Patent, March 28, 1889."

9398 Q. I place in your hands Letters Patent of the
3582 United States, 210,151, dated Nov. 19, 1878, granted to Wm. E. Sawyer for electric meter. Please to state whether Mr. Sawyer or yourself, or the Electro-Dynamic Light Co. made or caused to be made the instrument or apparatus described and illustrated substantially in that patent, at your shop, corner Walker and Elm streets?

A. We did, and ran it there in connection with our electric lighting system, and made patterns and ordered the parts made for several more.

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Said patent offered, in evidence and marked "Complainant's Exhibit, Sawyer-Man Electric Meter patent, March 28, 1889."

3399 Q. Between what dates were the several apparatus described and illustrated in these several patents to which we have been referring assembled, set up and used at the Walker and Elm street shop?

A. From the time we went to Walker and Elm streets,
3584 which, according to my recollection, I fix as the last of September, 1878, between that date and about the 15th, 16th or 17th of March, 1879, when I ceased to work in connection with Mr. Sawyer.

3400 Q. And were all of the electric lamps referred to by you in your testimony in the New York case assembled and set up in that shop, 94 Walker street during the same period?

A. Not all. The greater number were. Some were

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assembled and set up before we left 43 Centre street, in May or June, 1878. Some, and possibly a larger number, were assembled and set up after we left 43 Centre street, and before we went to 94 Walker street, at the shops at the corner of Howard and Centre streets.

3401 Q. State as nearly as you can how many electric lamps were certainly set up and illuminated at the Walker and Elm street shop between the 1st of October, 1878, and the 15th of March, 1879? 3586

A. I cannot fix that number, as I have stated before. It was a large number, in my judgment exceeding one hundred, and according to my recollection, as I look back upon it, running to between two and three hundred, but the manner of our work was such, lamps being used over and over again, and modified and changed in whole or in part, as to their interior works, but I cannot be certain in regard to the matter. I prefer to
say that a very large number of lamps, without fixing 3587
definite numbers, was made, set up, and run there between the dates given in the question, and further, the manner of their manufacture in separate and distinct parts by workmen and manufacturers outside of our shop, at separate and distinct places, and the finished parts being brought to us there and set up by us and run. Whether lamps in use were new or modified or refilled or refitted lamps is a matter which confuses my recollection.

3402 Q. Please to state whether or not, between the
dates you have given, Mr Wm. Sharp was employed at 3588
the shop of the Electro-Dynamic Light Co., corner of Walker and Elm?

A. He was, during part of the time.

3403 Q. State as near as you can recollect when his employment at that shop commenced, and when it terminated?

A. He commenced work at that place, I should

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think, some time about the middle or last of October, and continued in the employment of the Electro-Dynamic Light Co., with possibly some intermissions of a few days at a time, until about the 15th, 16th, or 17th of March, 1879, when I discharged him, and he was immediately re-employed by Mr. Wm. E. Sawyer, and continued at work at the same place, if I recollect correctly, with some intermissions, possibly, until about the middle of May, 1879, when the shops were broken up.

3590 3405 Q. Please to state the cause of Mr. Sharp's dismissal?

A. The Electro-Dynamic Light Co., and I, as its President, were dissatisfied with Mr. Sawyer, by reason of his drunkenness. I consulted with my co-trustees and with Mr. Sawyer, and remonstrated with him and told him that the work could not go on in that way, and, in substance, that if he continued his inebriation, we should shut up the shops. I consulted with my co-trustees, and it
3591 was agreed that if Mr. Sawyer did not mend his habits I should shut up the shop and discharge the employees, except Mr. Edwin Myers. I went to the shop at the time when I discharged them, found Mr. Sawyer drunk, and his father and Mr. Sharp both under the influence of liquor. I immediately sent to the bank for money, discharged and paid off all but Mr. Myers, and stopped the work, so far as the Electro Dynamic Light Co. was concerned. I reported my action to the Board at the meeting of the 20th of March, 1879, and
3592 it was approved. Before this meeting I had reported to the several trustees of the company what I had done, and why I had done it.

3406 Q. Previous to the closing of the shop, as you have stated in your last answer, and the termination of your co-operation and work with Mr. Sawyer, had you admonished him that unless he discontinued his in-

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temperate habits you would close the shop and discontinue your work with him?

A. I had.

3407 Q. Frequently?

A. Very frequently.

3408 Q. In closing the shop and discontinuing your work with Mr. Sawyer were you or the Electro-Dynamic Light Co. influenced in any way by the failure or any want of success of your electric lamp or inventions appertaining to your system of electric lighting?

A. In one sense we were, in another sense we were 3594
not. We believed in our system of electric lighting and in our electric lamps and in the patents that we had obtained and inventions that we had made, and believed that they were practical and successful, and it was not for any want of confidence in them that we stopped work, but in the work done by Mr. Sawyer, in his drunkenness. As to its practicability we had not confidence, and in that sense our action was influenced in stopping the work, by want of practicability in the lamps made and set up by Mr. Sawyer, or under his 3595
direction while he was drunk, and we attributed this want of practicability solely to Mr. Sawyer's drunkenness.

3409 Q. Had you any want of confidence in Mr. Sawyer to make the lamp and work all the inventions of your system if he would remain sober?

A. No, I had none, and I do not believe that any other members of the Board of Trustees had.

3410 Q. Referring now again to Mr. Sharp, please to state what opportunity he had of observing what 3596
was being done at the Walker and Elm street shop during the time he was employed there?

A. Mr. Sharp's place of employment was in the back room. He had little or no opportunity to know what was going on in the front room, except as he occasionally went out and into the building in going to or re-

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turning from his work he might possibly pass through the front room. He had an opportunity to see, if he looked, the work that was going on in the back room except such as was conducted in the engine room, which, from his position in the shop could not be seen by him ordinarily unless he left his work and went to the engine room door or entrance. How much he knew or understood of it, I don't know. He was not an electrician or chemist. His business was a metal
3598 finisher.

3411 Q. What were his duties or work as a metal finisher?

A. To make the pattern things according to drawings and directions for the different things he wanted to order made. And in this connection, the modifications which we wanted made in our lamps which we had run, were frequently if not usually placed in his hands. He sometimes assisted Mr. Myers or Wm.
3599 Sawyer in taking down lamps that had been run, but not usually, and in finishing up metal work of all kinds.

3412 Q. In what capacity was he employed?

A. Simply as an ordinary workman, a mechanic.

3413 Q. Did he occupy any confidential relation with either you or Mr. Sawyer?

A. We did not tell him of or discuss the things we wanted to do or accomplish in his presence or with him. His relations were only so far confidential that
3600 he was requested not to talk about the things that he did do, with any one outside.

3414 Q. Did that request extend to anything that he saw?

A. Yes, and the request was general to all the workmen in the shop.

3415 Q. Was it any part of his duty, or did he in fact assemble the several parts of the lamps and put them up at the shop?

3601

A. That was not his ordinary work, but was done by Mr. Wm. Sawyer, Mr. Wm. E. Sawyer and Mr. Myers, ordinarily. I think, however, that Mr. Sharp may have put up a few lamps.

3416 Q. Whose duty was it to make the carbons that were used in the lamps, and who, in fact, did make them and put them in the lamps?

A. Mr. Myers had charge of that matter under Mr. Wm. E. Sawyer and myself, and usually treated the carbons and put them in the lamps, exhausted and 3602
charged them and sealed them off. Mr. Wm. E. Sawyer, however, frequently put in carbons into the lamps, some that were made by himself, but mostly those that were made by Mr. Myers, and did a good deal of the electrical treatment of carbons which Mr. Myers ordinarily did, and Mr. Wm. Sawyer frequently put the carbons into the lamps and ordinarily set them up. Mr. Myers, under my direction, did all or nearly all the carbonizing in the furnace. I do not think Mr. Sharp had anything to do with carbon. 3603

3417 Q. In view of Mr. Sharp's position there, is it probable that he would know what the carbons were made of, how they were carbonized, or what kind of carbons were put in the lamps?

A. The fact is, that I thought that Mr. Sharp would know and recollect more than he appears to do by his testimony, at least as to the form of carbons and the carbonization and the materials carbonized. His opportunities for knowing were dependent only upon his own observation, and not upon information conveyed 3604
to him by us. As to the material of the carbons before treatment I should think it highly improbable that he could know what the material of the carbons actually treated was, further than that I think he saw the carbonization going on in the furnace by Mr. Myers, and might have inferred that it was the carbons thus made that were being treated by Mr. Myers and Mr. Wm.

3605 E. Sawyer. After the carbons were treated I do not think Mr. Sharp could know what they were made of. The carbons when carbonized were taken care of and locked up by Mr. Wm. E. Sawyer in his desk in the front room and in the drawer of the table in the center of the front room, to which Mr. Sharp had no access, of course. The carbons were given out by Mr. Sawyer to Mr. Myers to be treated and put in the lamps, and to his father to put in the lamps or in the holders for
3606 treatment.

3418 Q. Was Mr. Wm. Sharp's employment and the condition and arrangement of the shop and the division of the work such that many different kinds of carbon could be made there and used in the lamps without Mr. Sharp's knowing anything about it, unless he was specially told of it ?

A. Yes, such was the fact, and he could only know it by attending to that which was none of his business, or being told of it, but, at the same time, I had believed
3607 that Mr. Sharp, from the condition of things, must have positively known of the making of carbons from paper, wood and other substances, as according to my recollection Mr. Sharp made several kinds of punches for cutting out paper for carbons. It may be that I am mistaken in my recollection and that these punches were made by old Mr. Sawyer; still, even if Mr. Sharp made the punches, as they were not used in the back room, but all the material for carbons were cut and shaped in the front room, he may not have
3608 known what they were for. I mean to say, in this that there was abundant opportunity for Mr. Sharp not to know what was going on, and that he did, in fact, know, as I believed at the time, very little of what was being done. That part only which he could see and observe while attending to his work with his back to the rest of the shop, ordinarily, but the carbonization was conducted in a room connecting to that in which

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he was, and it seems to me that if he had exercised any thought upon the matter he must have known that the carbonization was for the purpose of electric lighting, and some of the materials that were carbonized were in plain sight in his room, and it was no infrequent thing for the vegetable and fibrous carbons to be openly exposed on the table and on Mr. Sawyer's desk in the front room. It is true, however, that Mr. Sharp had no business whatever in the front room. Again, these carbons were taken by Mr. Myers and Mr. Wil- 3610
liam E. Sawyer to the back room and treated upon the chemical platform right back of where Mr. Sharp usually worked. I think no explanation whatever was made to him, but he might have seen them.

Complainant's counsel states upon the record, in the presence of defendant's counsel, that, not having been able to get a copy of the deposition of Mr. William Sharp, he is unable to proceed with the examination of this 3611
witness as to Sharp's deposition, and, therefore, defers such further examination as to that deposition until he is able to get a copy of the same and proceeds with the examination of the witness on another branch of the case.

3419 Q. Please to state what, if any, correspondence you have had with any one connected with the Edison Electric Light Co. as to uniting the interest of the 3612
Edison Electric Light Co. with the interest of the Electro Dynamic Light Co. in incandescent electric lighting, and please to give the name of the person or persons with whom you corresponded, either in writing or orally, as President of the Electro Dynamic Light Co.

A. I had a correspondence with Mr. Grosvenor P. Lowrey, counsel now present, to whom I was referred by Mr. Wright, of Drexel, Morgan & Co., as the attor-

3613 ney of the Edison Electric Light Interest or Company. I don't know whether it was a company or being promoted by Drexel, Morgan & Co., and in which I understood Mr. Lowrey to have some personal interest. In the Fall of 1878, I invited Mr. Lowrey to our place, at No. 94 Walker street, and showed him our lights, or some of them, and some of the things we had. I had a conversation with him, I think, at my office, No. 3 Mercer street, upon the subject-matter of uniting in some way the Edison interest with the Sawyer and
3614 Man interest, with a view of preventing subsequent litigation and injurious competition. On the 30th of October, 1878, I received a letter from Mr. Lowrey dated that day upon this subject matter. On the 31st of October, 1878, I replied to that letter. On the 2d of November, 1878, I received another letter from Mr. Lowrey, dated that day, and on the 6th of November, 1878, I received another letter, dated that day, from him.

3420 Q. How was this correspondence initiated be-
3615 tween you and Mr. Lowrey?

A. First by my seeing glowing statements in the newspapers of what Mr. Edison was doing or about to do in incandescent electric lighting, and my thinking by the wide-spread notoriety of Mr. Edison in electric lighting and knowing what we ourselves had done, that it would be better to have Mr. Edison as a co-worker than an opponent; and second, hearing that Drexel, Morgan & Co., with whom I had frequent business at the time, were interested with Mr.
3616 Edison, I took occasion to speak to Mr. Morgan of that firm, and tell him in substance that we, Sawyer and Man, had done a good deal in electric lighting by incandescence, had some very good inventions and patents in regard thereto, and some good lights, and expressed my views personally that good business policy would indicate the propriety of a union of interests between us in the field of incandescent lighting. Mr.

Morgan referred me to Mr. Wright of that firm, as hav- 3617
ing charge of the subject matter, and Mr. Wright referred me to Mr. Lowrey as the attorney and interested in the matter. I saw Mr. Lowrey in accordance with Mr. Wright's suggestion. Then, or soon afterwards, I invited him, in some way, to go to 94 Walker street and see what we had. The result was the correspondence between us, the dates of which I have given.

3421 Q. Can you give the time of your first inter- 3618
view with Mr. Morgan?

A. No, except that it was a week or ten days, perhaps more, and it may not have been so long, before Mr. Lowrey visited 94 Walker street.

3422 Q. After your first interview with Mr. Morgan, how much time elapsed before your interview with Mr. Wright?

A. I think it was the same day.

3423 Q. How long after that before your interview 3619
with Mr. Lowrey?

A. At this length of time I cannot state with accuracy. My best recollection is, it was some days subsequent to my interview with Mr. Morgan and Mr. Wright, and it was several days after this before Mr. Lowrey came to 94 Walker street. I should think a week or more; perhaps it may have been two weeks.

3424 Q. What was the nature of your business with Drexel, Morgan & Co. at that time?

A. Buying foreign exchange of them, and buying letters of credit for my clients.

3425 Q. Please to examine the paper now shown you 3620
and state if you recognize it as one of the letters referred to by you as having been received by you from Mr. Lowrey?

A. I do; that is the letter dated October 30th, to which I referred.

Letter offered in evidence and marked

3621 "Complainant's Exhibit, Lowrey Letter of Oct. 30, 1878. March 28, 1889.

Adjourned till Friday, the 29th inst., at 11 A. M.

NEW YORK, March 29th, 1889.

Met pursuant to adjournment.

3622 Present—Counsel as before, and the examination of Mr. Man was continued, as follows:

3426 Q. You have referred to a letter addressed to you by Mr. Lowrey, dated Nov. 2, 1878. Can you produce the original of that letter?

A. I cannot and don't know where it is. The last I saw of it, it was in the hands of William E. Sawyer, then Secretary of the Electro-Dynamic Light Co., to the best of my recollection.

3623 3427 Q. Have you made search for the letter?

A. I made search through my papers some time ago for all the papers connected with the Electro-Dynamic Light Co., and am confident I haven't got it.

3428 Q. Do you know of your own knowledge that the record of that letter found in the minute book of the Electro-Dynamic Light Co. is a true copy of that letter?

A. I do. I compared all this correspondence, as recorded in the minute book with the original letter and

3624 press copy that I made of the letter. I wrote to Mr. Lowrey with the record in the minute book at the time they were made with Mr. William E. Sawyer, the then Secretary of the company.

The copy of said letter as recorded in the minute book of the Electro-Dynamo Light Co. is offered in evidence, and is marked

"Complainant's Exhibit, Lowrey's Letter of Nov. 2, 1878. March 29, 1889." 3625

Counsel for defendant, Mr. Lowrey, being present, notwithstanding the general reservation of the right of objection till the close of Mr. Man's testimony, states that he will cause a search to be made for a letter press copy of such letter, if it exists, and will produce it for the use of the complainant if found, but as he had no recollection of such a letter, he now 3626
notes as an objection to this method of proving the letter, that a sufficient ground has not been laid for producing a copy in place of the original, and that the original, if produced, and the copy are incompetent, irrelevant and immaterial as between the parties to this action and upon the issues thereof.

3429 Q. Please to examine the paper now handed you and state if you recognize it as the original letter 3627
written you by Mr. Lowrey, November 6, 1878?

A. This is the original letter dated November 6, 1878, to which I referred, addressed to me by Mr. Lowrey, and received by me and recorded in the minute book of the Electro-Dynamic Light Co.

Letter offered in evidence and marked "Complainant's Exhibit, Lowrey Letter of November 6, 1878. March 29, 1889."

3430 Q. Are these three letters all the letters you 3628
received from Mr. Lowrey on the subject of this correspondence?

A. I can only say that I think so, and that I do not recollect any others.

3431 Q. Are these letters in the handwriting of Mr. Lowrey and signed by him?

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Mr. Lowrey being present and shown the letter of November 6, says that the signature is his, and from examination of the two letters of October 30 and November 6, he has no doubt they were both written in his office although the letter of October 30th does not purport to be an original letter, but to be a copy, both as to its body and signature, and he has no doubt that it was written by his
3630 direction

A. I think this answers your question fully. They are the original papers received by me from Mr. Lowrey.

3432 Q. Was the other letter, I mean the letter of November 2, 1878, in the handwriting of Mr. Lowrey.

A. I think the letter of November 2nd purported to be a dictated letter from Mr. Lowrey. My impression is that it was in typewriting, but of this I am not cer-
3631 tain. It may have been manuscript. It is referred to in the letter signed by Mr. Lowrey, personally, dated November 6, 1878, and there stated to have been dictated to his stenographer by him.

3433 Q. What, if any, answer did you make to these letters that was in writing?

A. I answered according to my recollection in writing, only the letter from Mr. Lowrey to me, dated October 30, 1878, and my answer thereto is recorded on pages 31, 32, 33 and 34 of the minute book of the Elec-
3632 tro-Dynamic Light Co. My letter is dated October 31 1878, and its receipt by Mr. Lowrey is acknowledged in his letter to me of November 6, 1878, and in his letter of November 2, 1878.

3434 Q. Can you produce the original of the letter referred to by you in your last answer?

A. I cannot,

3435 Q. Why?

A. I sent it to Mr. Lowrey.

3633

3436 Q. Was it recorded in the minute book before you sent it to Mr. Lowrey?

A. It was not.

3437 Q. From what was the record made in the minute book of that letter?

A. From a letter-press copy of that letter which I made before I sent it.

3438 Q. Can you produce the letter-press copy from which the record was made?

A. I cannot; I gave it to Mr. Sawyer, the Secretary 3634
of the Electro-Dynamic Light Co., to record it in the minute book, take care of it, and file it with the papers of the Electro-Dynamic Light Co.

3439 Q. Did you compare the record of that letter in the minute book with the letter-press copy you have mentioned, and do you know of your own knowledge that the record of the letter in the minute book is a true copy?

A. I did so compare it with the record in the min- 3635
ute book with Mr. Wm. E. Sawyer, the Secretary, and I believe it to be a true copy of the letter I sent to Mr. Lowrey, and think I know it is.

Counsel for complainant calls on defendant's counsel to produce the original of this letter, to be offered in evidence.

Mr. Lowrey being present, says that counsel for defendant has never received any such letter, that in his personal character Mr. Lowrey will examine his file of personal letters 3636
deemed to be of sufficient importance to be preserved, and if such a letter is found he will produce it. That he has no present recollection of receiving such a letter.

The record of letter referred to as found in the minute book of the Electro-Dynamic Light Co. is offered in evidence as "Complainant's Exhibit, Man's Letter to Lowrey of

3637 October 31st, 1878, March 29th, 1889," with the understanding on behalf of complainant's counsel, that if the original is produced it may be substituted for the copy found in the minute book.

3440 Q. Did you have any personal interviews with Mr. Lowrey regarding the subject matter of these letters? If so, please to state what was said at such interviews, as you recollect it?

3638 A. I had several interviews with Mr. Lowrey prior to his going at my invitation to No. 94 Walker street, in which I endeavored to impress upon him my views that it would be advantageous to both the Edison people and the Electro-Dynamic Light Co. that their interests should be united and their inventions worked together, rather than to be antagonistic or rival interests, this, as a business proposition, addressed to business men. I myself at the time believed that we were very far in advance of Mr. Edison in incandescent electric
3639 lighting, as I saw his attempts and experiments published in the periodicals of the day, and as I had heard of them from others, and I expressed this belief to Mr. Lowrey as an inducement to the Edison people to unite with us. On the day of his visit to 94 Walker street Mr. Lowrey and I went from that place, according to my recollection, to my office, No. 3 Mercer street. We there had had a conversation in which Mr. Lowrey, in substance, expressed himself pleased with what he had seen and that it was more or better, or both, than he
3640 had anticipated, and promised to confer with other people interested in the Edison invention or inventions, and I think we canvassed in some measure, the appointment of committees on the part of the Electro-Dynamic Light Co. on the one side, and on the part of the Edison Electric Light people on the other side, or Mr. Lowrey for them, to confer together in regard to the propriety of a union of interests and the basis of a

union, if any should be deemed practicable, or advisable, and Mr. Lowrey at this interview, I think, promised to further confer with me or write me. And on receipt of his letter on the 31st of October, 1878, on the same day the Electro-Dynamic Light Co. at a meeting of its trustees, did appoint such a committee of whom I was one, and I verbally advised Mr. Lowrey of their appointment, and some further conversation was had between us of a like character to that that had gone before. 3641
I think this was the same day or the day following the 31st of October, 1878. I do not think I had any further conference with Mr. Lowrey after the receipt of his letter dated Novemer 2, 1878, which was a surprise to me, until long afterwards at several times when I casually met him, and simply possibly referred to the subject-matter, I think in the summer of 1880, after the organization of the Eastern Electric Manufacturing Company, I again brought up the subject-matter of either a union of the interests of the Electro-Dynamic Light Co. and the Edison Electric Light Co., or the sale of the patents and inventions of the Electro-Dynamic Light Co. to the Edison Electric Light Co. with Mr. Lowrey, but nothing was accomplished and the matter was dropped. 3642 3643

Adjourned one hour for lunch, to resume at 2 P. M.

Resumed at 2 P. M. 3644

Witness continues.

Several persons indirectly approached me and the other directors of the Electro-Dynamic Light Co. to know whether the patents and inventions belonging to that company would be sold. It was, after conference between myself and other trustees, thought best that I should call on Mr. Lowrey in regard to the

3645 matter, as it was supposed or understood that these inquiries came from or were instigated by the Edison Company. I accordingly called on Mr. Lowrey in regard to the matter, referred to previous attempts at negotiation, and perhaps to the inquiries that had been made, and asked him whether the Edison people desired to enter into negotiations. He told me, as near as I can recollect, that he was not advised of any such thing, that it was hardly in his province then,
3646 that other people had charge of such matters, and advised me, I think, to see Mr. Wright, of Drexel, Morgan & Co. This, I think, is the substance of what took place in the summer of 1880, as I recollect the time of it.

3441 Q. Referring now to the correspondence and interviews with Mr. Lowrey in the fall of 1878, when did such interviews and correspondence terminate?

A. Immediately after my receipt of his letter of November 2, 1878, so far as any conference was con-
3647 cerned, or interviews. The last correspondence, so far as I know or recollect, was his letter to me dated November 6, 1878.

3442 Q. Was he then one of the counsel of the Edison Electric Light Co?

A. I only know from his being a lawyer and from being referred to him, and by my interviews and correspondence with him. I supposed him to be so.

3443 Q. How often did Mr. Lowrey call at the shop of the Electro-Dynamic Light Co. on the corner of
3648 Elm and Walker streets in the fall of 1878?

A. I only remember the one occasion to which I have testified, and which is referred to in the correspondence between us.

2444 Q. Was that occasion in the daytime or in the evening, and were your lamps exhibited to him at that time?

A. My recollection is that it was in the daytime, and that the room was darkened by putting up mov-

able shutters which we had at the windows, that several lamps were lighted up and turned off to show that one could be turned off without affecting the others, and turned down to less incandescence by means of switches to show that one lamp or more could be run at one incandescence while the others were running at a different incandescence, the lamps individually giving such light as was desired within their limits of luminosity; that the dynamo-electric machine that was running the lamps was shown to him, 3650
and the switch or switches by which the lamps were turned off and their luminosity governed.

3445 Q. State, if you recollect, how many lamps were in circuit at that time?

A. I cannot state further than that I remember that several were lighted at the same time in order to show that one could be turned off or reduced in brilliancy without affecting the others.

3446 Q. What was the duration of Mr. Lowrey's visit that time, as you recollect it? 3651

A. I could not undertake to state that at this length of time, definitely. My impression would be from half an hour to an hour.

3447 Q. Do you know anything of a visit of Mr. Lowrey to the works of the Electro-Dynamic Light Co., corner of Walker and Elm streets, in the spring of 1879? If so, please to state what knowledge or information you have about such visit?

A. About a week or ten days after the 20th of March, 1879, I knew of Mr. Sawyer having invited gentlemen 3652
from, or representing the Edison Company; to witness an exhibition at evening of our electric lights and apparatus at that place. I was not present at the exhibition inside the building, but saw the illumination of the building, or our rooms, as I passed by there, and I heard that the Edison people were there that evening, and that Mr. Lowrey was among them. I do not know it personally, except the reputation.

3653

3448 Q. This exhibition made by Mr. Sawyer at that shop, mentioned in your last answer, was after you discontinued to work with him, as I understand you, and after you had closed the shop, so far as the Electro-Dynamic Light Co. was concerned?

A. It was, and also after Mr. Sawyer had made a proposition to the Electro-Dynamic Light Co. to interest other people, which had been accepted, at least provisionally by the Electro-Dynamic Light Co., and the exhibition was made by Mr. Sawyer, as I under-
3654 stood, in order to interest other people in accordance with his proposition.

3449 Q. As I understand you, you had no personal knowledge of this exhibition beyond what you have stated, or of the causes which led to it. Am I right in my understanding?

A. Not quite. I knew that the exhibition was to be made; I knew the object of the exhibition, and knew that it was made. I knew the object of it through Mr. Sawyer, and I think, Mr. Church. I have already stated
3655 in my testimony that it was made by Mr. Sawyer in pursuance of an attempt to carry out his propositions before then made to the Electro-Dynamic Light Co. to interest other people.

Counsel for defendant, Mr. Lowrey, calls the attention of the counsel for complainant to the intention already expressed by Mr. Lowrey to limit, so far as is possible, the future cross-examination of this witness, in order
3656 that the already overburdened record may be limited as far as is practicable. He also calls attention of counsel for complainant and of the Court to the character of the testimony, being called out and permitted from the witness, it being a very large part hearsay and inference from assumed facts which would seem to force upon counsel for defendant a

prolonged cross-examination to separate that 3657
which is really material and competent from that which is not so, and lest counsel for complainant may be misled and also the witness by the absence of any present objections, under the arrangements heretofore made, he now calls attention to the tendency of the testimony, both questions and answers, to spread beyond suitable limits, and asks counsel to restrain it. Mr. Lowrey makes this statement not in any way imputing either to wit- 3658
ness or counsel a purpose of this sort and merely to guard them against what must necessarily lead to the statement of broad objections and to the unnecessary prolongation of cross-examination.

Counsel for complainant says in reply that he has finished his examination of the witness upon the topics upon which he has been last examined, and that he has asked him no more questions than he thought were fairly neces- 3659
sary to corroborate the testimony of other witnesses that he proposes to call.

3450 Q. Please state how the Consolidated Electric Light Company came to be formed?

A. Sawyer having fallen out with Messrs. Wallace, returned to New York in the month of September, 1879, in a very antagonistic frame of mind and demanded a license under the patents to go on and manufacture, although he knew the Messrs. Wallace & Sons held an 3660
exclusive license from the company. This was refused him. Thereafter he devoted himself to active antagonism to the Electro-Dynamic Company and its interest in every way.

In the early part of 1880 he succeded in organizing an opposition company entitled the Eastern Electric Manufacturing Company, and in the meantime he de-

3661 voted himself to writing articles to the newspapers, which he told me were intended to injure the Electro-Dynamic Light Company and myself, and to belittle the work that we had done, and in this connection he wrote a book entitled "Sawyer on Electric Lighting." Mr. Edwin Myers was taken sick in the fall of 1879, and after a lingering illness died. There was no other person acquainted with the manufacture except myself, and I was too absorbed in other business, which I
3662 could not leave to attend to it. The hostile activity of Mr. Sawyer and the Eastern Electric Manufacturing Company, which he had organized, continued, Sawyer refusing to unite in applications for patents, re-issues and in the prosecution of interference proceedings, and otherwise injuring us, until finally, in order to put an end to the matter, an agreement was made by which the patents and inventions belonging to the Electro-Dynamic Light Company were in the spring of 1881, sold and conveyed to the Eastern Electric Manufactur-
3663 ing Company. Sawer agreed that he would thereafter cease his hostility and work actively for the interest of the patents. This he did for a little while. He soon became hostile to the Eastern Electric Manufacturing Co. His habits were so bad that no one could work with him, and he had parted with, hypothecated and sold all his interest in the company. Then, in order to get the patents actively at work, a consolidation was made with the American Electric Light Co., which agreed to furnish capital and go on with the work, and
3664 the Consolidated Electric Light Co. was the result of this union, which was effected in the fall of 1882, and the business of manufacturing and selling incandescent electric lamps under the patents of Sawyer and Man, has been actively carried on from that date.

Adjourned till Saturday, the 30th inst., at 11 A. M.

3665

SATURDAY, March, 30th, 1889.

Met pursuant to adjournment.

Present—Mr. Broadnax for Complainant, and Mr. Lowery for Defendant, and the examination of Mr. Man proceeded as follows:

3451 Q. Referring again to the testimony of Mr. Wm. Sharp, he says in answer to question 50 as to machinery, that you had at Walker street:

> "They had a small dynamo, a lathe, a grind- 3666
> stone, a boiler and engine. I might say there were two vices in there."

Is that a description of all the machinery you had at that place?

A. It is not.

3452 Q. How is it deficient?

A. There was all the time two dynamos, a large one of the largest size then built by Arnoux & Hochhausen, 3667
and a small one built by them, and part of the time three more dynamos. There were two lathes there, a chemical bench, permanently fitted up, a water exhaust, permanently fitted up, mercury exhausts, barometers and mercurical guages, permanently fitted up to the wall above the chemical bench or table, galvanometers, on the same bench, switches and other electric apparatus, and a very complete and extensive chemical apparatus, a set or partial set of carpenters' tools, and tools for doing special work, 3668
turning tools and bench tools of all kinds, a steam engine and boiler, and on the partion in the back room an electrical meter and a number of switches, a locked cupboard at the south end of the workmen's bench, to the right of Wm. Sawyer's place, filled with work and apparatus and materials, and at the other end of the bench a cupboard with a cloth cover at the left of where Mr. Sharp worked, filled with chemical apparatus

3669 and materials. In the front room there was a large table in the centre. At the south side, between the windows, a table filled with testing and measuring apparatus, with a set of galvanic batteries underneath it; opposite that, on the other side of the room, a large screen; on the north side, next the hall, was Mr. Sawyer's private desk and revolving chair, and there was a set, I think, of half a dozen common chairs in the room. There was on the centre table a variety of testing apparatus. There was a stand for a camera
3670 and photometer, used for both, lamps put up on brackets on all sides of the front room, arrangements on the chandelier for lamps, a movable lamp on the centre table connected to the chandelier; in the back room, brackets at different points for setting up lamps, apparatus for treating carbons in both oil and gas, and a great variety of things I can't enumerate. I have omitted several switches in the front room and several in the back room, an electric circuit running in both
3671 rooms, and electrical resistances, rheostats fastened to the walls and partitions. One of the lathes was a large or medium-sized lathe, intended to be run by power, and adapted to doing a great variety of work. It also had a pedal that could be attached, but was too heavy to be run practically by foot. The other lathe was quite small and adapted only to turning. It was a foot lathe.

3453 Q. What do you mean when you say you had a "water exhaust" in the shop? Please to describe
3672 it, stating its general construction and mode of operation?

A. It consisted of a lead pipe, thirty-six or eight feet long, run from the roof of the building down through the light or air-shaft at the north-west corner, with an enlarged air chamber at the top. Through the top of the air chamber, soldered in, entered the water pipe, connected on our floor to the Croton water system,

with a faucet for turning the water on or off. This 3673
pipe was diminished in size in the air chamber at its lower end, and nearly entered the air pipe connected with the lower end of the air-chamber, of which I have spoken. The waste pipe at its lower end was turned up and had an air-tight reservoir or trap, large enough to hold water enough to fill the pipe with water as high as it would rise with atmospheric pressure. From the upper air-chamber at its upper end ran a small lead pipe, soldered into the air-chamber, 3674
which passed down to our floor in the light-hole, and from thence through the brick wall, and was carried on the north wall of the building to a point just above the chemical table, where it ended with a small stop-cock and screw nipple, by which to connect it with the exhaust system of the lamps. This is a general description only.

3454 Q. Was this apparatus used to exhaust the lamp chamber of its air?

A. It was. 3675

3455 Q. What degree of exhaustion in your last chamber was attainable by this apparatus?

A. Sometimes more and sometimes less, according to the flow of water in the Croton water system. When the flow of water was good we could obtain by it an exhaust whose pressure was substantially equal to the tension of water vapor at ordinary normal temperature of the atmosphere, or about that. It was such an exhaust that the height of the mercury in the gauge which measured it could hardly be distinguished 3676
from the height of the mercury in the barometer standing beside the mercury gauge.

3456 Q. What other, if any, apparatus did you use in your shop at the corner of Walker and Elm streets, for the purpose of exhausting your lamps?

A. The ordinary mercury exhaust, on the principal of the Bunsen or Geissler pump, worked by filling a chamber with mercury, driving out the air, shutting

3677 the stop cock to the space desired to be exhausted, and then allowing the mercury which filled the chamber to escape through a vertical tube of the length of about thirty-six inches, and repeating the operation. I also had a Sprengle pump. I do not now remember or recall whether it was used there or not.

3457 x-Q. Mr. Sharp in his deposition testifies as follows:

3678 [Counsel reads from queston 213, of his examination in chief, to 216.]

Please state who made that lamp. I mean the lamp of figure 49 in Sawyer's book?

A. Referring now only to the spiral leading-in-conductors of that lamp, made of concentric spiral tubes, for the first lamp of this pattern Mr. Sharp turned from wood the form for bending the tubes constituting the conductors, and he and I bent them and fitted them together and fastened them to a diaphragm and a lamp
3679 base at his place in Brooklyn, in the month of April, 1878, according to the best of my recollection. I have a distinct recollection of the work and of the difficulties we met with in executing it and keeping and fastening the conductors so that they would not by the least movement touch each other, and so, short circuit the lamp. It is proper, however, to remark in justice to Mr. Sharp, that I did not tell him and he did not know what he was doing or what the apparatus was for, and that the holders above the diaphragm were
3680 not put on by him, but were at 43 Centre street, and that this apparatus was separate and distinct from the two lamps to which he has referred in his testimony and was made before either of those to which he referred.

3458 Q. Referring to the lamp marked "the horseshoe lamp, figure 52 in the Sawyer book, what kind of carbons were used in that lamp?

A. Mostly, if not entirely, carbons made from wood 3681
and paper. It may be that some few lamps were set up of this form with circular discs or rings turned from sheet French carbon or sheets of gas-retort carbon; but I do not think so in lamps of this size, or diameter of lamp chamber.

3459 Q. The carbon burner of this lamp as it appears by this drawing in Sawyer's book, appears to be thicker at its junction with the holders than in the
center. How do you account for that appearance? 3682
A. We made carbons that were so, but this may be in the illustration, only a fault in drawing or representation, or it may represent a flat twisted paper carbon, of which we used some.

Adjourned for lunch.

Re-umed after lunch.

3460 Q. What do you mean by a flat twisted paper carbon? Please to take a piece of paper, cut it and illustrate what you mean?

"Witness takes a piece of paper, cuts it, 3683
and says: "I bend it in the form of a loop and "twist it, at the same time so that the plane "of the paper at its two ends will be the "same, so as to be held in the two holders "flatwise, as illustrated.

3461 Q. Do you mean by that that the ends of the conductor when twisted as you have illustrated will show the breadth of the conductor, and the top of the arch will show the thickness of the paper?

A. Yes, that is it.

3462 Q. And did you mean such conductors as long 3684
as this shown in Figure 52 of Sawyer's book?

A. Yes, I think so, and longer.

3463 Q. Referring now to the carbons made of willow about which you have testified; of what kind of willow did you make such carbons?

A. We made them from willow osiers—basket willow

3685 —which I got, and from willow twigs, from weeping willow.

3464 Q. What part of the weeping willow did you use?

A. The pendulous twigs of the growth of the year or year previous, both, the long sweeping branches or twigs of the weeping willow.

3465 Q. How did you prepare them for carbonization?

A. Selecting them, removing the bark, some of them
3686 that were fine enough, boring out the pith, bending them and carbonizing them whole, after being bent, some of them carbonizing in straight pencils without being bent, with and without the pith removed in both cases. Some of them we split up, shaped them to the size we wanted, then bent them and carbonized them or carbonized them in straight pencils. The same with regard to the osier or basket willow, except that none of these were small enough to form conductors and so had to be split and shaped to size.

3687 3466 Q. Where your carbons proved defective how long would it take to take the lamp apart and put in a new carbon?

A. Where one lamp alone was taken, perhaps ten minutes. If more were taken in a batch, a less average time, but if the lamp required any cleaning it would take longer.

3467 Q. In that case, give the maximum time it would take in the hands of a fairly skillful man?

A. Mr. Sawyer was accustomed to say, and I think
3688 he was correct, that he could take down and set up from ten to a dozen lamps an hour, putting new carbons in them.

3468 Q. How many lamps and parts of lamps did Mr. Sharp make for you before he went into the employ of Sawyer and Man?

A. That would be impossible to tell, as to the parts,

because he worked at a great many parts of different lamps and made other parts for lamps which we already had, to change their internal work. I do not now remember but two lamps that were made complete at his shop in Brooklyn, or at most three, and those did not have the carbon conductors in them. The two that he has mentioned and the concentric spiral lamp, which I have mentioned; I do not think the holders for the conductor were in this last mentioned lamp, but they may have been. I don't think he put them in, but I don't know. The best of my recollection is 3690
that he did not.

3469 Q. Mr. Sharp testifies in cross-questions and answers 567 and 568, inclusive, that there were no galvanic batteries in the office room, corner of Walker and Elm streets. What is your recollection about that?

A. There certainly were, as I have testified. I have them now and can produce them.

3470 Q. Re-direct question 603 of Sharp is as follows: 3691

> "At your home or shop in Brooklyn did "you ever bore several dozen glass base-" plates for Mr. Man or Mr. Sawyer?
>
> "I have a slight recollection of drilling one "or two holes, but no such quantity as one or "two dozen."

What is your recollection as to that?

A. My recollection of the subject-matter is that 3692
before we got molds for making the holes in the glass base-plates of the lamps at the same time that they were blown, that I had the holes bored in them by a lapidary in Ann street, New York; that I took one of those over to Mr. Sharp's place to have him fit the tubular binding-screws to it; that something happened to it, and that I proposed to get another one bored; that Mr. Sharp told me that that was un-

3693 necessary, as he could drill them. I asked him how he would do it, and he said with an ordinary steel drill. I had never heard of such a thing before and it was new to me, and I asked him to show me how he did it. He got a piece of glass and took a steel drill, and after hardening it, drilled the glass with it; but in doing so the inside or further part of the glass where the drill passed through last was bursted out around the edges; that to prevent this we got a tube and after drilling
3694 with the steel drill until the point of the drill came through the glass we used the tube with emery and water or turpentine, and succeeded in making smooth holes through the glass. We were having at the same time these glass base-plates made at the glass factory in Brooklyn, and finding that Mr. Sharp could drill them, as I was returning home, I called at the glass factory, got my pocket full of the glass bases, took them to Mr. Sharp and he did drill them. I wish to add that in none of these cases did Mr. Sharp know what the
3695 things he was doing were for, at least, I did not tell him. I mean during the period while we were at 43 Centre street, except in the one case some time after his work was done, I told him it was for an electric lamp.

3471 Q. What other interferences did you have with your patents other than your interference with Mr. Edison?

A. We had an interference with Maxim & Keith, declared March 4th, 1879. That interference was dis-
3696 solved March 2nd, 1880. We had also an interference with Brush & Fuller, which was declared April 29th, 1879, and dissolved January 4th, 1880. We had also an interference with Hiram S. Maxim, declared August 16th, 1880, dissolved July 10th, 1883. We had also an interference with Edward Weston, declared October 1st, 1881, and decided September 24th, 1884. The subject matter of the first interference was treating

and making carbons for incandescent electric lighting 3697
electrically in an atmosphere of hydro-carbon. The subject matter of the second interference was an electrical switch for controlling the currents in electric lighting. The subject matter of the third interference was an electric regulator for governing currents in electric lighting. The subject matter of the fourth interference was for the treatment of carbons for incandescent electric lighting in a hydro-carbon bath or atmosphere. 3698

The complainant having called Albon Man, and offered in evidence his printed testimony and accompaning exhibits taken in the case of The Consolidated Electric Light Co. vs. The Edison Electric Light Company, pending in the Circuit Court of the United States, in the Southern District of New York, and in like manner, his printed testimony and exhibits taken in the interference proceedings be- 3699
tween Sawyer and Man, and Thomas A. Edison, and it being understood that said Man is to be produced as a witness in this case to be subject to further cross-examination upon the testimony in the said two other cases; should defendant desire it after reasonable opportunity to examine the printed testimony now offered, the defendant now consents to the introduction of said testimony and exhibits without other objection than such as already 3700
appear upon the records now introduced.

Counsel for defendant notifies counsel for complainant that defendant now offers to enter into the same stipulation in respect to the testimony of any witness for Sawyer and Man in the interference above referred to, who shall be produced by the complainant for

3701 further cross-examination, as Mr. Man has been.

[Counsel's note: The testimony of Albon Man taken in the interference case referred to above, is printed in Volume 3 of this record as follows: First deposition, pages 102-125; second deposition, pages 205-210; third deposition; pages 572-600.]

3702 Adjourned till Monday, April 1st, at 3 P. M.

TUESDAY, April 2d, 1889.

Met pursuant to adjournment.

Present—Mr. Broadnax for complainant and Mr. Lowrey for defendant, and the examination of Mr. Man was continued as follows:

3703 3472 Q. State, if you please, who did the carbonizing at your shop at the corner of Walker and Elm streets?

A. Mr. Edwin L. Myers, principally under my direction. I did some, and Mr. William E. Sawyer, I think, did a little.

3473 Q. Please to state if you recollect of making any lamps at your shop at Walker and Elm streets of the form substantially shown by the sketch now shown you?

A. I do.

3704 3474 Q. State if you recollect how many of such lamps were made?

A. I cannot be precise as to numbers at this date, of that exact form of globe; my best recollection, I would say, about a dozen.

3475 Q. Please to state how they came to be made, and state if you have any parts of such lamps that you can produce?

A. We had blown while we were at the corner of Centre and Howard streets a number of sizes of globes, 3705
as many, I think, as six or seven different sizes in diameter and of great variety and length. They were mostly straight tubes, with a flange at the lower end like test tubes in shape, but some of them had round bulbs blown on the closed end of the tube. The smallest size of these globes or lamp chambers had an internal diameter of about one inch and their length was from four to six inches; we had them set up at 3706
about the time of our going to Walker and Elm streets, or soon afterwards, a batch of something like a dozen lamps. Some of these had little round bulbs at the top. I did not like the shape of them. It was not pretty and after trying to draw something satisfactory to myself I called upon my friend, James McDonough, an artist and designer, and now President of the American Bank Note Company, and he drew for me the design of the tulip-shaped bulb shown in the drawing which I have produced and which I made. I took the 3707
drawing to Mr. Hahn, glass worker, in North William street, and about a dozen of the straight tubes of the internal diameter of about an inch and the length of about four to six inches, already ground and fitted to the glass discs or bases of the lamps already used, and on which the works were set up, and the workman at Mr. Hahn's (they called the workman "Gus." I think his name was August Wedekind) blew the upper part of the tubes into the tulip-shaped form of bulbs, and I took them back to our shop in Walker street and had 3708
the lamps set up in them, and they were run there. I am unable to produce any parts of these lamps except the short spiral conductors, which I now produce, and do not know what became of them. I only know we had them and ran them. I produce a piece of soapstone from which the diaphragms of these little lamps were turned, showing the diameter of the diaphragm of these small lamps in its circular part. I may have

3709 some of these diaphragms and might be able to produce them, but I have not found them yet. My attention was called to this matter in regard to this little lamp by the testimony of my daughter, Mrs. Ives, yesterday. I have spoken in my testimony of the small lamps and lamps with bulbs, but not those, if I recollect right, of this particular form.

3710 Drawing and conductors and soapstone produced by witness, offered in evidence and marked "Complainant's Exhibits Man Drawing of tulip-shaped lamp and exhibit conductor of tulip-shaped lamp, and soapstone "or disc of tulip-shaped lamp, all of April 2, "1889."

3476 Q. Please to take the sketch produced by you and mark its several parts with letters or figures of reference, and describe its several parts on the record?

A. No. 1 is globe of lamp with flange; No. 2, glass
3711 base; No. 3, binding screws and cups with stop-cock; No. 4, binding screws of clamping rings; No. 5, clamping rings; No. 6, upright carbon clamps for incandescent conductor; No. 7, incandescent conductor; No. 8, copper conductors corrugated; No. 9, diaphragm soapstone.

3477 Q. What kind of carbons were used in those lamps?

A. Mostly small circular rings or loops. I think one or two of them were fitted up for straight pencils.

3712 3478 Q. What were they made of?

A. Carbonized wood and paper usually.

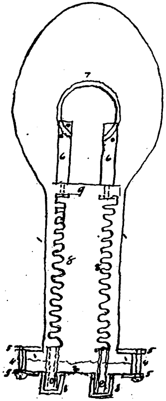
3479 Q. Cut to size before carbonization?

A. Yes, sized and shaped before carbonization.

3480 Q. Who, if any one of your family, did you take to see these lamps?

A. Early in the fall of 1878 I took some friends, Mr. and Mrs. Greenough, who were visiting at my house

Consolidated
v.
McKeesport.
Complts Exhibit
Man drawing
of tulip shaped
lamp April 2/89
WJJ
S.E.



my daughter Ida, and my sister-in-law, Alice Watkins 3713
(the two ladies who testified in my presence here yesterday), over to our shop in Walker street, and showed them our lamps, as the ladies testified yesterday. This was soon after our going to Walker street. I do not mean to testify that this kind of lamps was what was shown to them, for I do not remember, but I do wish to be understood that at that time we had the small lamps of this kind, and also many other kinds of lamps. 3714

3481 Q. When did you make the sketch which you have produced?

A. I made it in pencil-mark last evening, finished and inked it this morning and just now.

3482 Q. Does the sketch represent the lamp as made by you in 1878 as accurately as you can now recollect it?

A. It does, as accurately as I can recollect. It is not drawn to scale, except approximately, by the eye. It does correctly represent the general appearance of 3715
the lamp.

3483 Q. Do your daughter and Miss Watkins identify it as of the form of globe which they saw and about which they testified yesterday?

A. They do, both of them.

Cross-examination by Mr. Lowrey:

3484 Q. In the letter produced by you referred to in your 3419th interrogatory, purported to be signed 3716
by Mr. Lowrey, dated October 30th, 1878, there appears to be a reference to an article in the morning paper. I hand to you a copy of an article from the New York *Times* of October 30, and ask you whether you understand that that is the article referred to?

It is understood that the copy referred to in the question is to be compared with the

3717

original and corrected by the Examiner, and when so corrected to be treated as original.

A. Several of the newspapers contained more or less extended notices of our lights, I think, on the morning of October 30th; of course I cannot say what one Mr. Lowrey referred to in that letter; I think the New York *Times* published an article that morning; my recollection is that it has already been introduced in evi-
3718 dence; I may be wrong.

3485 Q. Have you now read the *Times* article, and do you find the statements therein contained substantially correct?

A. Substantially correct, only as a newspaper reporter would write out on account of what he saw.

3486 x-Q. Do you see anything in that article to which you would wish to call attention as being incorrect in substance?

A. The reporter assumes, perhaps, in the article that
3719 he knew all that Sawyer and Man had done. I think he gives a pretty correct description, so far as it goes, of what he saw.

3487 x-Q. Can you tell from whom this or other reporters about that time obtained this information, whether from you or Mr. Sawyer, or both?

A. The reporters had been running there to our shop. We had to stop our lathe to run the dynamos. We would just simply show them the light and get rid of them, to go on with our work, not only reporters,
3720 but other people. I think Mr. Sawyer sent notice to all the papers to have them all come at once, and they did come and the lights were shown to them. I was present part of the time. While I was there they asked questions of Mr. Sawyer and of myself, some of which we answered, and some of which we did not an-

3721

swer, and the next morning these articles came out in the papers.

3488 x Q. Mr. Man, I call your attention to cross-interrogatory 5, addressed to Franklin L. Pope, in this case, and hand you at the same time an electric lamp bearing the stamp of Sawyer-Man upon the metal socket, and will ask you while examining the lamp to listen to the description of a lamp which I take from the interrogatory above referred to, and will ask you to say whether that is a correct description of the structure and mode of making of the lamp now in your 3722
hand?

"The lamp consists of what may be called two parts, one part consisting of an enclosing globe or bulb made entirely of glass; the other part consisting of an incandescing conductor and wires to which it is attached in the interior glass portion. The inside part contains a filament of carbon, first united mechanically and then electro-plated to two small 3723
platinum wires. These platinum wires pass through the glass, the glass being sealed around the wires by the fusion of the glass. The inside part is then inserted in the glass bulb, and the seal is made by hermetically sealing the glass bulb and the glass of the inside part by fusion of the glass: the lamp, as an entirety, being now complete, the air is exhausted from the top of the bulb, where the 'tit' is, and which previously was an open 3724
tube, and, after being exhausted, a hermetical seal is made at this point by the fusion of the glass."

A. In regard to the lamp you hand me, the description is a substantially correct one, except in particulars in which I am not able to judge from the mere appearance of the lamp, to wit: The attachment of the

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carbon conductor to the leading-in-wires or conductors and to the atmosphere of the lamp, of which I can know nothing by appearance. The description is not accurate as to the manner in which the leading-in-conductors are passed into the lamp, nor in the support of those conductors.

3489 x-Q. Are those the only divergences of substantial importance that you note?

A. Yes.

3726 3490 x-Q. State if you know, by whom that lamp was manufactured, and for what purpose?

A. I do not know, except for the purpose, apparently, of electric lighting.

3491 x-Q. Do you not recognize that as a lamp of the Consolidated Company, made under the Sawyer and Man patents?

A. No; not of the Consolidated Company nor the Sawyer and Man Company. I do not wish to be understood that it was not made by them, but that I do
3727 not recognize it. The particular part of it that I do recognize is the attachment of the conductor to the leading-in wires.

3492 x-Q. Does this lamp conform in all essential particulars to the principles of construction under the Sawyer and Man patents with which you are familiar?

A. I think it contains many of the things which we patented, or substitutes or equivalents for them.

The lamp is offered in evidence and marked
3728 "Defendant's Exhibit Sawyer and Man Electric Co.'s lamp, No. 1, April 2, 1889."

3493 x-Q. I hand you now another example of a lamp, and ask you to state what that this, if you know?

A. That is, I think, a Sawyer and Man Lamp, made by the same company.

Said lamp put in evidence, and marked

"Defendant's Exhibit Sawyer and Man Electric Co.'s Lamp, No. 2, April 2, 1889." 3729

3494 x-Q. Tell me, if you know, whether lamps of the type of either of these exhibits are in general use in connection with the electric lighting system of the complainant?

A. I know only that many lamps similiar in general appearance to these, without going into details as to construction, are in use all over the country, and I understand them to be put out under the general 3730
direction of the complainant, or its licensees.

3495 x-Q. I now show you a lamp which has been put in evidence in the case of the Consolidated Electric Light Co. vs. the Edison Electric Light Co., in the Southern District of New York, and marked "Complainant's Exhibit, No. 21, Edison's Incandescent Electric Light, Timothy Griffith, Examiner, October 9, 1886," and which is understood to be identical with "Exhibit Defendant's Lamp" and referred to in interrogatory 4, of Franklin L. Pope herein, and will ask 3731
you to compare it with Exhibits 1 and 2, referred to in the last interrogatory, and say in what essential particulars, if any, the latter differs from the two former lamps? I do not refer to non-essential mechanical details, but only to such particulars as affect the character of the respective lamps, as consisting chiefly of fibrous, arch-shaped incandescing conductors in chambers, wholly of glass and hermetically sealed?

A. You wish me to leave out then all the mounting of the lamps and consider them simply as to the glass, 3732
leading-in-conductors, atmosphere and carbon?

Counsel says "yes."

Witness continues:

The construction of the three lamps is very similiar; a slight difference in the shapes of the globes, a difference in the support of the leading-in conductors and the carbon conductor; a difference between No. 2 Exhibit

3733

and the Edison lamp in the attachment of the leading-in wires to the carbon conductor. I cannot tell how the attachment between the leading-in conductors and the carbon conductor is made in Sawyer-Man lamp, No. 1 Exhibit. In the Edison lamp it is evidently electro-plated with copper. In the Sawyer-Man lamp I do not know that I have ever seen one like it and don't know how it is connected.

3496 x-Q. What appears to be the material of the carbon in each case ?

3734 A. Carbonized fibrous material.

3497 x-Q. By what do you judge that it is fibrous material ?

A. I know of no way by which such conductors as these appear to be can be made except from fibrous material. It is proper to remark that all the conductors appear to my eye to have been treated in some manner by deposit of carbon upon them.

3498 x-Q. From your experience in the making and
3735 inspection of lamps, do you doubt that these carbons are as stated in the question to Mr. Pope and to yourself, made from bamboo fibre ?

A. I have no knowledge whether from bamboo fibre or some other fibre. I simply know that bamboo fibre would make such carbons, and if asked should say that they look like carbons made from bamboo fibre.

3499 x-Q. You have spoken in your recent re-examination in chief of refitting and refilling and cleaning of lamps. Will you explain in a general way the occa-
3736 sions which occurred in your experience, or were expected to occur in the use of your lamps, for refitting or refilling a lamp, and how this would be done ?

A. All our lamps, while Mr. Sawyer and I were working together, were made so as to be readily taken apart, so that anything could be readily done to the interior work of the lamps, such as substituting carbon conductors, or restoring vitiated atmosphere or an at-

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mosphere not suitable to the incandescent lamp. The word "filling," as used by me, covers exhaustion of the atmosphere filling with an inert gas, repeating the process of exhaustion and filling, heating up the walls of the lamp and heating up the interior of the lamp, and especially the incandescent conductor by an electric current, and finally leaving the lamp sealed up with an atmosphere of inert gas, or a vacuum of such gas. Perhaps it would be better to say, such a gas at different pressures from a little below atmospheric pressure 3738
to a substantial vacuum. The method of doing this, while Mr. Sawyer and I were working together, was to take out the screws holding the bindings together, remove the sealing, open the stop-cocks to let the air in in case there was an attenuated atmosphere in the lamps, then remove the glass plate to which was attached all the interior works of the lamp. If any purifying were required, clean the parts as attached to the glass base-plate; if the carbon were a straight pencil carbon, remove it, or any remains of it, and put an- 3739
other in its place, wash out the globe with alcohol, or ether or both; put the interior works of the lamps which were on or attached to the glass base-plate into the globe proper, and screw the two part together with the binding screws and rings. The refilling was done in the same manner as the original filling, all the lamp requiring to be filled or exhausted being connected together in one batch, and all done together. By refitting, I mean this, that we were frequently and often changing the carbon holders and their adjustments 3740
with the carbon incandescing conductor, and these changes I call refitting. In the straight pencil lamps the method of holding them in the carbon clamps or holders was very frequently changed. This I call refitting. Again, the parts of the lamp above diaphragm (which diaphragm is represented in the exhibits you have presented me to-day, by the glass support of

3741 the leading-inconductors) were frequently changed to use carbons for incandescent conductors of different shapes, or lengths, or sizes, such as the change from straight pencils to arch-shaped carbons of greater or less diameter, or the reverse, from arch-shaped to straight pencils of greater or less length. The occasion for doing this was to make a lamp within all its parts, except the incandescent carbon conductor, would be permanent, and to make a lamp of such construction that
3742 a new incandescent conductor could be substituted in the lamp, which itself was permanent. The further occasion in our practice for the thing was like this: The testing of contacts between the holders and the incandescent conductor, the testing of the atmosphere of the lamp and the durability of the incandescent conductors of different shapes, forms and sizes, and of different methods of attachment to their holders. We almost continually took down good lamps to examine microscopically the incandescent carbons. We
3743 also frequently took down good lamps because, by reason of the formation of electric arcs at the points of contact, we found that such contact had not been made perfect electrically. We obsereved these arcs when the lamps were set up by means of a camera and screen by which a picture of the carbon while incandescent was thrown upon the screen of very large size, and when we found the least appearance of such an arc or defect, or the least appearance of the consuption of the corbon, or of defect in the carbon, such as
3744 unequal resistance at different parts of it, we usually took the lamp down, refitted or refilled them, or both, or sometimes ran them to light our shops, but not for exhibition. In the straight pencil lamps some of these lasted a very long time. Many of them were good lamps, but we thought them not reliable.

3500 x-Q. I understand then, Mr. Man, that you contemplated that in use the illuminating part or car-

3745 bon might be subjected to injury or destruction, and the design of the lamp was to allow renewal or repairs without sacrificing the lamp chamber itself or any of the uninjured parts of the structure?

A. Yes, we did so contemplate and we did not know as we do now, the average life of the carbon conductor, and we thought it desirable to make a lamp in which a new carbon conductor should be substituted for one that should give out for any cause or at any time. 3746

3501 x-Q. You understand that we are speaking of the lamp of the patent in suit?

A. I mean the lamps made by Mr. Sawyer and myself, one of which is illustrated in the drawings of the patent in suit.

3502 x-Q. Look at figure 2, attached to the patent in suit, and say whether that is intended to illustrate a lamp upon the plan and to attain the purposes which you have explained?

A. The illustration, figure 2, is from the drawing ac- 3747 companying the application for the patent in suit, and was made from an actual lamp given to the draughtsman from which to make it, which was one of the lamps made by Mr. Sawyer and myself, while at 94 Walker street, in our work for making a practical incandescent lamp, and is one of the plans used by us for that purpose. It is a lamp that may be readily taken apart and set up again, as I have described.

3503 x-Q. Is that lamp, as thus designed and constructed within, according to your understanding, the 3748 second and fourth claims of the patent in suit?

A. First, as to the second claim: I answer, yes, if the incandescent conductor is made of carbonized, fibrous material. Second: As to the fourth claim, I answer, yes.

3504 x-Q. Please look again at Exhibits 1 and 2 of to-day and 21 of the New York case, referred to in a

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previous answer, and say whether their construction contemplates or permits the opportunities and advantages of repair or change which you have spoken of in your answer to interrogatory 3499 and subsequent questions?.

A. They do not in any practical sense; that is, they cannot be readily taken down and set up again. I suppose, indeed I know, that a skillful glass-blower could take those lamps apart and a new carbon could be sub-
3750 stituted or other change made in the interior of the lamp, and the lamp be again closed, refilled or exhausted, or both, and run again, but it would cost more than to make new glass parts for the lamp, preserving the metal parts.

3505 x-Q. Do you mean to say that it would be practical to do that with the lamp of the patent in suit, on the score of cost?

A. Yes, it could be readily taken down and a new carbon substituted, and the lamp be re-charged or ex-
3751 hausted, and in many places to-day a lamp adapted for this purpose would be highly desirable. In referring to the lamp of the patent in suit I simply refer to the type of lamp illustrated in the patent in suit, and do not mean to be understood that the invention sought to be covered by the patent in suit is limited to that type of lamp. If you refer to the cost of taking down a lamp and putting in new carbon conductors in lamps of the type of that illustrated in the patent in suit, the cost is entirely within the limits of practicability for many purposes for which incandescent lamps are or
3752 could be used to-day.

Adjourned till Wednesday, 3d inst., 1 P. M.

3753

WEDNESDAY, April 3d, 1889.

Met pursuant to adjournment.

Present—Mr. Broadnax for complainant, and Mr. Lowrey for defendant, and the cross-examination of Mr. Man proceeded as follows:

Mr Man here says: "I wish simply to say "that in my answer to cross-question 3499, "while I say that all the lamps made by Mr. "Sawyer and myself were made so as to be 3754
"readily taken down, &c., that my statement "was intended by me as a general statement. "The word 'all' is too broad, taken specifi-"cally, as a few lamps made by Mr. Sawyer, "in which I did not participate, and one or "two made by myself, were not intended to "be taken down. If the word 'nearly' is put "before the word 'all,' my answer would be "correct."

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3506 x-Q. Where are the one or two lamps which you have just spoken of as made by you; can you produce them, and will you?

A. I don't know. I at one time gave one of them to Mr. Broadnax, my counsel. They were made by Mr. Sharp and substantially illustrated by the drawing made by Mr. Sharp.

3507 x-Q. Do you now produce one of those lamps?

A. Yes, one of those made by Mr. Sharp, but not the one he illustrated. 3756

3508 x-Q. Has this lamp which you now produce been in use?

A. Yes, I think so, only experimentally.

3509 x-Q. Please explan what was the arrangement of circuits and of incandescent conductors, if there were to be more than one used in that lamp?

A. It was intended for two incandescent conductors.

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3510 x-Q. Where and for how long a time had you that in use?

A. At 43 Centre street while we were there. I should think in the month of March, 1878. The only use we made of it was simply a trial and not permanent use. The tubular conductors in the trial we made of it were covered at their ends with India rubber tubing, and the tubing, after charging the interior of the lamp, was simply pinched together. The carbons were passed in
3758 through the tube and impinged upon the cross-piece hinged upon an upright held by a spiral spring in a central tube. The other lamp had lead tubing soldered to the ends of the tubular conductors after the carbon was put in, and had only one carbon, and after the lamp was charged the lead pipes were pinched together and melted to make them air tight. This lamp does not appear to have been run long enough to have determined any advantage in it, and so had not the
3759 means of permanently sealing it up attached.

3511 x-Q. There were two lamps similar in character, as I understand, one of which you produce, where is the other?

A. I don't know. It was at our shops. I don't know what became of it. It was never used after we left 43 Centre street.

3512 x-Q. Did you ever see it after leaving there?

A. No, sir.

3513 x-Q. You say the carbons were pushed up
3760 through the tubes in that lamp, Was it so in the lamp with the lead tubing?

A. Yes; there was only one carbon in the lamp, and the upper csrbon piece was held rigidly instead of a spring as in this case, and the carbon conductor was held up to it by a rod of carbon of the size of the bore of the tube, into which the end of a straight pencil carbon was inserted, and under the rod of carbon was a spiral spring to hold the carbon pencil up to the up-

per contact piece of the lamp. The holes through 3761
which the tubes pass are bored in the glass and sealed with binding screws.

3514 x-Q. Did you insert the pencil or carbon before or after you had filled the lamp chamber with the atmosphere?

A. Before.

3515 x-Q. There are pieces here at the lower end of the tubular conductors which unscrew and come off. Were they removed for the insertion of the carbon and 3762
the filling of the lamp chamber?

A. They were removed for the insertion of the carbon, but were replaced and had lead tubes soldered to them before the charging of the lamp chamber. Not in this lamp, but in all glass lamps that Mr. Sharp illustrated.

3516 x-Q. What was the carbon material used in this lamp and the other?

A. Straight pencils of French carbon.

3517 x-Q. Do you mean the Carre Carbon? 3763

A. Carre or some other French manufacture.

Said lamp put in evidence and marked "Defendant's Exhibit Experimental Lamp Produced by Man, April 3d, 1889."

3518 x-Q. How many types of lamps had you from the beginning of your work with Sawyer until its close in March, 1879?

A. I don't know that I could state. I have gone over that very fully, and it is only by going over from 3764
first to last all the work that we did that I could enumerate the different types. There were two general classes of the lamps, straight pencils and arched pencils, or V or other shaped, in which latter the incandescent conductor rose above or extended beyond both the holders or conductors leading to it.

3519 x-Q. I understand you to say that Exhibit con-

3765 ductors put in evidence April 2, 1889, are examples of part of the smaller forms of lamps?

A. Yes, the shorter forms of lamps. I think that they were used in the smallest form of lamps, but I can't be certain. I am sure that they were used in the shorter form of lamps. They were conductors of this form that were used in the smallest form of lamps, perhaps of less size.

3520 x-Q. If I understand your recent testimony
3766 correctly, you made and set up between two and three hundred lamps of these various forms?

A. That is my estimate. I do not wish to be understood as swearing to positive numbers.

3521 x-Q. The lamps which you had were then made for your own use experimentally and otherwise?

A. It would be more accurate to say that they were not used, to my knowledge, except by ourselves and by Mr. Sawyer, after he separated from the Electro-Dynamic Light Co., unless they were used by some other
3767 people by direction of Mr. Sawyer in this later period. They were made, most of them, with a view of being sold.

3522 x-Q. Did you know in 1878 and 1879 of any rule by which you could have determined which was the better kind of fibrous material for your use without experiment?

A. One thing we took into consideration: The purity of the fibre to be carbonized. Our rule was to get as pure cellulose as possible, in which there was as little
3768 admixture of other things than gasses and carbon (particularly metals or their bases), as possible. Another thing was to get a dense fibre, or one that was not too porous; another thing was to get a fibre that was uniform and that could be easily worked and put in shape before carbonizing. These rules, except the first, were learned by us very early by experiment. The first was determined when we determined to use carbon

in our lamps. I do not know of any experience or rules of others at that time except the high resistance of pure carbon to heat, its high melting point, its infusibility. 3769

3523 x-Q. By means of these experiments and the application of these rules, were you enabled within the range of the materials which you examined to select the better and reject the worse natural fibres for your purpose?

A. We thought so, so far as our experiments extended, but it is proper to say our experiments and selection by means of them were limited to our then forms of lamps. 3770

3524 x-Q. Did you make any experiments as to the kind of vegetable fibre most desirable, having in view standards of resistance in the incandescing conductor, standards of size in main or distributing conductors, and other standard conditions of a business in which current is to be supplied from a central station for use in towns, cities or villages? Did you assume conditions 3771
for this purpose?

A. We made experiments and calculations with reference to all things you mention.

3525 x-Q. Were there any of these conditions in respect to which you made these experiments and calculations in which you found willow carbon the best for the purpose?

A. I don't know or recollect.

3526 x-Q. Were there any of these conditions in respect to which you made these experiments, in which 3772
you found carbonized paper the best for the purpose?

A. Confining myself to central station plant lighting. I do not know or recollect.

3527 x-Q. In your cross-examination you were asked (964 x-Q.): "Now, if a person wanted to make a lamp "under this patent with an incandescent conductor of "fifty ohms resistance, what would he have to make "the length or cross-section of his carbon?" and you

3773 "answered: "I cannot tell without knowing the "carbon that he was using and its resistance, and then "only by experiment." Would not that be a correct answer in respect to any kind of carbon in any of the lamps which were made by you?

A. No, not in the sense that we could not or did not make carbons of any fixed or determined resistance which we desired. In the sense that I would have to know the elements I have mentioned there, of resist-
3774 ance in a particular case, before I could determine how to make the carbon, it is a correct answer. By "elements of resistance" in the conductor, I mean the specific resistance of the carbon to be used and its dimensions in either length or cross-section, which were not given to me in the question then asked.

3528 x-Q. Would the material of the carbon as to whether it was one vegetable or another vegetable fibre have anything to do with determining the question?

A. Yes, both the material and its treatment before
3775 carbonization.

3529 x-Q. Suppose in 1878 and 1879 you had wished to use incandescent lamps in multiple arc in the number of ten lamps of sixteen candles each for each horse power of current, and to attain the best duration of which you then had any experience, which one of the woods with which you were then familiar would you have selected as best for the purpose?

Objected to as not cross-examination and not material.

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A. I speak from recollection that I think we should have selected willow, and treated the carbons.

3530 x-Q. Was that judgment the result of experiments which you tried on various kinds of wood?

Same objections

A. It is a recollection only of what I think we would

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have done in looking back now upon the experiments we tried.

3531 x-Q. Are there any uses in electric lighting to which bamboo carbon would be applicable, and in which willow carbon would be either inapplicable, or less applicable.

Same objections.

A. I don't know; there may be, or may not.

3532 x-Q. Is willow carbon, to your knowledge, used 3778
anywhere at present in electric lighting?

Same objections.

A. I have seen some lamps with willow carbon, a year or two ago. I don't know whether there is any use made of them now. I think it would be a good material to use now for some of the incandescent lamps.

3533 x-Q. Do you know whether there is any way of ascertaining if you are right in your last answer, ex- 3779
cept by experiment?

Same objections.

A. Yes; I think I could go to work and make good lamps of willow carbon, or, at least, I think I could.

3534 x-Q. Do you mean that they would be commercial lamps in modern systems of lighting?

Same objections.

A. I mean that they would be good commercial 3780
lamps in some of the modern systems of electric lighting, in my opinion.

3535 x-Q. Have you any experimental experience, or are you answering according to your judgment merely?

Same objections.

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A. I have not made any lamps since I quit working with Mr. Sawyer. I have advised in regard to the making of lamps at different times since then.

3536 x-Q. On page 48 of the minutes, on the eighth line from the bottom, I find the word "Sawyers" between the word "his" and the word "judgment," interlined. Tell me, if you know, in whose handwriting is the interlineation.

3782 A. In Mr. Sawyer's, I think.

3537 x-Q. Is the whole page in his handwriting?

A. Yes.

Adjourned till Thursday, the 4th inst., at 1 P. M.

NEW YORK, April 4, 1889.

3783 Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Man was continued as follows.

3538 x-Q. You have referred to Mr. Lowrey's visit to the shop of Sawyer and Man on the 30th of October, 1878, and have stated that you then exhibited to him your light. Please state whether you showed or communicated to Mr. Lowrey anything more than had been on the day previous communicated to the vari-
3784 ous representatives of the press?

A. I think that we exhibited to Mr. Lowrey about the same as was exhibited to the representatives of the press the day before, and in about the same manner. The lamps exhibited to him, according to my recollection, had straight pencil incandescent conductors, and we told him that we made them of carbon. I do not recollect of anything being said of how our con-

ductors were made or of any discussion of the carbon, 3785
except simply that we made them and they were of carbon; of course I cannot say at this length of time whether we told Mr. Lowrey some things that we did not tell the press representatives, or whether we told the press representatives some things that we did not tell Mr. Lowrey.

3539 x-Q. I hand to you what purports to be a letter signed by you and addressed to Charles A. Cheever, Esq., dated Dec. 12, 1880, and ask you to say 3786
whether that is your letter, and whether it was sent to Mr. Cheever at or about its date?

A. Yes.

Said letter offered in evidence and marked "Defendant's Exhibit Man-Cheever letter, April 4, 1889."

Re-direct examination. 3787

3540 R-d Q. What, if any, profit have you made out of your enterprise in electric lighting entered into by you and Mr. Sawyer?

A. I have made none, and have no prospect of making any, and on the contrary, have put a great deal of money aside from my time, of which I see a prospect only of recovering a part.

3541 R-d Q. You have stated that Mr. Sawyer resigned the offices of Secretary and Trustee in the Electro-Dynamic Light Co. in the spring of 1879. 3788
State if you have refreshed your memory since as to the date of his resignation, and make such corrections as you wish to?

A. I think I stated when first examined in this case before Mr. Kitchen, Examiner, that my impression was that Mr. Sawyer resigned in the spring or summer of 1879. I have not the means of referring to my

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testimony now, but that is the impression I have in
regard to it. I have since refreshed my recollection by
reference to the minute book of the Electro-Dynamic
Light Co., which I had not then and had not for years
before been able to examine. I find by the minutes
of the meeting of the Trustees of the Electro-Dynamic
Light Co., in my own handwriting of Nov. 20, 1879,
that Mr. Sawyer's resignation was accepted at the
meeting of that day. I find by the minutes of the
3790 meeting of October 7th, 1879, at which Mr. Sawyer
was also present and at which meeting no business
was transacted except to adjourn, that I acted as
Secretary, although Mr. Sawyer was present. My
recollection therefore is that Mr. Sawyer offered his
resignation in the fall of 1879, and before or on October 7th.

3542 R-d Q. State whether or not you have recently
furnished the Consolidated Electric Light Co., or the
Sawyer-Man Electric Company, its licensee, with parts
3791 of Sawyer-Man lamps, to be used by them in the construction of such lamps, to be used as exhibits in this
case, and if yea, please to state what parts you furnished?

A. During the year last past I have furnished to
them the parts of the Sawyer-Man lamps, enough for
about from thirty to fifty lamps, made or caused to be
made by Mr. Sawyer and myself (while we were working together) for the Electro-Dynamic Light Co., in
1878 and 1879, and which I have had in my possession
ever since then. I delivered these to Mr. Robertson,
3792 Mr. Packard and Mr. Garden. The parts, I think,
were complete for nearly all the lamps, except the
carbon holders, possibly some diaphragms and the
carbon incandescing conductors. They were glass
globes, glass base-plates, binding rings, tubular binding screws, with stop-cocks, cups to cover the stop-cocks and binding screws, corrugated leading-in con-

3793
ductors, spun caps for covering the base of the lamps,
made of sheet metal. I have also given to Mr. Packard, Mr. Shallenberger and others instructions as to
the making and purification of nitrogen gas and the
details of work in setting up and sealing the lamps,
and part of the material I furnished was sent to Mr.
Shallenberger at Pittsburgh.

3543 R-d Q. Please to give the name of the person
who put up for you at your Walker street shop the
water exhausting apparatus referred to by you in your 3794
answer to question 3453?

A. David Hennessy.

3544 R-d Q. In the article taken from the New York
Times of October 30, 1878, and put in evidence by
defendant's counsel, it is stated:

> "The pencil of carbon is heated by the
> "electric current with a temperature of from
> "30,000 to 50,000 degrees Fahrenheit, in an
> "atmosphere within with it cannot chemi- 3795
> "cally combine."

State, if you know, what authority there is for that
statement?

A. Mr. Sawyer and I made experiments to ascertain
what degree of heat carbon would endure without
softening or becoming flexible. Our experiment was
made in this way; we took different metals whose
melting points were known, placed them in our lamps,
passed through them currents of definite quantity and
electro-motive force to heat them up to the melting 3796
point, turning in the electric current gradually. We
took carbon conductors and turned into them currents
of the same electro-motive force and quantity, or amperes, as those at which the different metals melted.
We took into consideration the resistance of both the
metals and the carbon conductors and their specific
heats. From this we ascertained, or thought we did,

3797 in a rude way, approximately, the temperature of the carbon conductors at different degrees of luminosity. From this we deduced a rule of temperature of the carbon conductors as their luminosity increased. It was a rough and crude way of approaching the subject, but from it we came to the conclusion that pure carbon would soften and bend at a temperature of 30,000 to 50,000 degrees. Mr. Sawyer was in the habit of stating that we had found out that these carbons that
3798 we used would stand from 30,000 to 50,000 degrees Fahrenheit. I never heard him make the statement that we ran our lamps at such a temperature, and I think I certainly never made such a statement. I know of no other authority for its being stated in the newspapers than that I have given. I think the reporters must have got the idea from some statement of what degree of heat we thought carbon conductors would endure.

ALBON MAN.

3799 Counsel for complainant offers in evidence a diagram made by the defendant's witness, Wm. Sharp, of the Walker street shop, in answer to question 547 of his deposition, and the same to be taken as part of his said deposition, the same is marked "Complainant's Exhibit, Sharp's diagram of Walker street shop, April 4, 1889."

3800 Adjourned till Friday, April 5th, 1889, at 1 P. M.

[End of Albon Man's deposition in McKeesport case.]

3801

NEW YORK, January 23, 1890.

Met pursuant to adjournment. Present: Counsel as before.

The witness being further cross-examined deposes as follows :—

78 x-Q. Having reference to the experiments which you have detailed as having been made at the times stated, by Mr. Sawyer and yourself, did you not know 3802 that other persons had been, or then were, engaged in endeavoring to produce an incandescent electrical lamp?

A. Before Mr. Sawyer and I met in January, 1878, in the year in 1878, we both knew that attempts had been made by several persons to make such lamps, which attempts we understood had met with more or less success. From that time forward until the fall of 1878, I did not know and do not think Mr. Sawyer did, 3803 of any persons engaged in such attempts, except ourselves. Some time in the fall of 1878, I think in September or October, we both saw in the newspapers articles purporting to come from, or to be instigated by Mr. Edison, showing that he was endeavoring to produce such lamps by the use of platinum, iridium and other metallic conductors for the incandescent portion of the lamp, and this continued until some time in December, 1879, when I heard, for the first time, that Mr. Edison was endeavoring to use carbon 3804 for the incandescent part of the lamp.

79 x-Q. Does your last answer mean that between January 1878, and the fall of 1878, you did not know and had not read or heard of attempts being made by any other persons to produce an incandescent electric lamp, but that such knowledge was then confined to a period prior to January, 1878?

A. Yes, that is my recollection of the matter. I

3805 fancy attempts were made that I heard of. I do not recall them. I know that during this period we thought (or at least I did) that we were the sole persons then working at the matter, as my recollection now goes.

80 x-Q. Having reference to such attempts as you know of, prior to January, 1878, had you ever heard or read, or did you know that other persons were endeavoring to use for the purpose of electric lighting
3806 glass globe, or other glass environments ?

A. Yes.

81 x-Q. Did you know, or had you heard, or read, that in connection with such globes or glass environments, such persons were endeavoring to use a burner made of carbon of some sort ?

A. Yes.

82 x-Q. Did you know, or had you heard, or read, that such carbons were to be connected electrically with wires leading into such glass globes or glass en-
3807 vironment ?

A. Yes. Wire connected to the incandescent conductor, and wires leading in the glass globe or environment between the ends of which no conductor except rarefied air was used between the ends of the wires leading into the glass globes or environment. This refreshes my recollection that I knew between the time of January, 1878, and the fall of 1878, that lamps of this character in which no incandescent conductor was used, were being made, as a common article.

3808 83 x-Q. Prior to January 1878, did you know or had you ever heard or read, that the carbon burner in an electric lamp had been attempted to be made from wood or wood charcoal ?

A. In an arc lamp, yes ; by using charcoal. I do not know of wood, except that charcoal is a product of distillation of wood; what I mean is that I never heard or knew, before we did it ourselves, of a conductor being

made first of wood and then charred after being formed 3809
to shape and size of a conductor.

84 x-Q. Prior to January 1878 did you know or ever hear or read that any other form for a carbon conductor had been attempted to be used, except a straight pencil thereof?

A. No, I do not think I ever did.

85 x-Q. Prior to January 1878 did you know or had you ever heard or read, that it had been attempted to make the glass globe more fitted for perfect use, by 3810
endeavoring to exhaust the atmospheric air therefrom, replacing the same by nitrogen gas ?

A. Yes, I have heard of the use of nitrogen gas. Whether in connection with exhaustion I do not know positively. My best recollection is that I had not heard of it, but I had heard and read of the glass chamber of the lamp being exhausted of atmospheric air, and in that condition sealed up in different ways to preserve the exhaust or vacuum.

86 x-Q. But you do not now think that prior to 3811
January, 1878, you knew or heard or read, of the filling of such vacuum with nitrogen?

A. I mean to say that I am not positive in regard to that matter. Connecting the exhaustion with the gas, I feel very confident that I had never heard of exhausting the nitrogen gas from the chamber of the lamp for the purpose of leaving a nitrogen atmosphere of a high degree of exhaustion in the lamp as a permanent atmosphere of the lamp.

87 x-Q. On your direct, and when speaking of the 3812
Sawyer and Man lamps, you spoke of more or less of them as being constructed with nitrogen in the glass globe or chamber. Was such use of nitrogen in such chamber, novel and original with Messrs. Sawyer and Man ?

A. Where the nitrogen was of the ordinary pressure of the atmosphere, no. But where the atmosphere of

3813

the lamp consisted of a nitrogen exhaust, *i. e.*, where there was little or no atmosphere in the lamp, and that remnant of atmosphere was nitrogen, I believed then, and still do, that it was original with us.

88 x-Q. The ordinary process for using nitrogen at any pressure would involve, would it not, the exclusion so far as it could be attained, of ordinary atmospheric air?

A. It would, but to accomplish this purpose, it was
3814 not necessary that the air should be exhausted or pumped out of the lamp.

89 x-Q. What would be necessary in order to secure the removal of the atmospheric air?

A. Passing nitrogen through the lamp until the atmospheric air was carried out of the lamp, by dilution, or substitution of nitrogen for the air, or by making use of a difference in the specific gravity of nitrogen and air, introducing nitrogen into the upper part of the lamp and driving air out of the lower part
3815 of the lamp, and continuing the process until all the air was driven out and only nitrogen left in it.

90 x-Q. And it is your present opinion that this *modus operandi* was original with Messrs. Sawyer and Man?

A. Why no—not the process of substitution, dilution, or the like without exhaustion.

91 x-Q. Would not the ultimate practical effect of this *modus operandi*, which you have just mentioned, be the same so far as the exclusion of atmospheric air is concerned, as if such air had been pumped out and
3816 then the vacuum refilled with nitrogen?

A. With proper refinements and additional operations, it would; if these were not introduced in the process of getting rid of the air, the effect would not be practically the same. In the exhausting process the air contained in the walls and the interior works of the

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lamp (the occluded gases) would be more removed than in the process of substitution.

92 x-Q. Were these refinements and additional operations the subject of description in the Sawyer and Man patents?

A. Yes, sir, in some of them, as used both in the process of substitution and the process of exhaustion, as practiced by us.

93 x-Q. Having reference to the period prior to January, 1878, did you know or had you heard or read
that other persons had attempted, or were attempting, 3818
to produce an incandescent electric lamp, contemplated the closing of the glass chamber after the introduction of the burner and its electrical connections?

A. Yes, I think, if my recollection serves me right, that Crooke had done so, and probably some others. I think also King, and probably Lodyguine and Kosloff.

94 x-Q. In which, if either, of the description of the four names you have given above was it stated that the glass chamber was not to be filled with nitrogen, but
was to be used for an incandescent lamp in vacuum, 3819
after the air was exhausted?

A. I did not desire to confine myself to those names. I think Crooke, in one of his experiments, published prior to 1878, shows such a lamp in which there was a platinum incandescent conductor. I think King, in his patents and descriptions, also gives an account of such a lamp. One other person, perhaps more than one, had made experiments before them, in which a torricellian vacuum was established in the chamber of the
lamp, after the lamp was set up—I mean the incandes- 3820
cent portion introduced into the chamber of the lamp. I cannot specify others.

95 x-Q. Can you give the name or country of the other person referred to in the last answer?

A. I cannot, without referring to the books and publications.

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96 x-Q. When was the first lamp which, to your knowledge or information, had an incandescent burner in a shape or form other than that of a straight line or pencil?

A. The first lamp that I know of, of that kind, was made by Sawyer and myse'f in the Spring of 1878. This was the first of my acquaintauce or knowledge of this form of burner, but subsequently, in the year of 1880, I heard that others had made burners of plati-
3822 num of a form other than straight pencils, some years prior to 1878.

97 x-Q. Did you intend to be understood as stating on the direct that Messrs. Sawyer and Man had made lamps which were used with a vacuum chamber and without the presence of nitrogen therein?

A. We did make such lamps and run them.

98 x-Q. Having reference only to the beneficial effect upon the burner, and upon the light and the duration hereof, and upon the lamp generally of the use
3823 of a vacuum chamber, what was the difference in principle, so far as the vacuum was concerned between the lamps of Messrs. Sawyer and Man and the vacuum chamber of Crooke, King and the other persons you have above referred to?

A. I think that the vacuum obtained by Crooke was a very perfect one. The vacuum obtained by Sawyer and Man, as a vacuum, was not as perfect, I think, as that obtained by Crooke, though it was in some cases very perfect. But this was remedied by us ordinarily
3824 by having a remnant of atmosphere that was left in the lamp an inert gas. The vacuum obtained by the others, I suppose to be less perfect than that obtained by Sawyer and Man.

99 x-Q. Please assume a Sawyer and Man's vacuum had attained the same perfection as that of Crooke, and then kindly answer the last question with reference to the two vacuums?

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A. The principle was the same; the purpose of both being to remove from the chamber of the lamp anything or everything that would injure the incandescent conductor when highly heated up, as I suppose.

100 x-Q. On the direct you prodilced two Sawyer and Man lamps and one Sawyer lamp. Does the internal apparatus in either of such lamps tipify or represent the internal apparatus of the Sawyer and Man vacuum lamps?

A. Yes. 3826

101 x-Q. How many of these vacuum lamps were made and used?

A. All of our lamps, substantially, had a more or less perfect vacuum in them varying from an internal pressure, as I estimate, of two-thirds atmosphere, to a very perfect exhaustion or vacuum.

102 x-Q. Excuse me, your direct was supposed to contain a statement that the Sawyer and Man chambers of two kinds, those in which nitrogen displaced the atmosphere and those in which a vacuum was used, 3827
without presence therein of nitrogen. Was this supposition erroneous?

A. No, perhaps not. But the manner in which the conclusion seems to have arisen is that the lamps containing nitrogen were also vacuum lamps ordinarily, and the lamps in which no nitrogen was used at one time were the same lamps in which nitrogen was used at another time.

103 x-Q. In the uses of these chambers, sometimes with nitrogen, sometimes with less of it, or in vacuum, 3828
did you re-utilize the same carbons and internal apparatus?

A. Always the same internal apparatus. Sometimes the same carbons and sometimes others.

104 x-Q. Did you file specimens of your lamps on your applications for patents?

A. I do not recollect.

3829

105 x-Q. Did the re-use of the chambers and internal apparatus characterize the entire period of your union with Mr. Sawyer from March, 1878, until March, 1879?

A. Yes, our lamps were used over and over, modified from time to time.

106 x-Q Having reference to such of the lamps as had in them the least nitrogen, or the most perfect vacuum, how many of such lamps did you actually
3830 sell to the public between March 1878 and March 1879?

A. I do not remember or know of any sale of any of our lamps, unless it be some lamps that were furnished to Messrs. Wallace of Ansonia, in March, April or May, 1879, for which, I believe, they paid Mr. Sawyer subsequently, if that may be considered a sale. They were for sample lamps.

107 x-Q. Having reference to the kind of Sawyer and Man lamps of which the three produced on the
3831 direct are types, can you state the average cost of such lamps as a whole?

A. Do you mean the cost to The Electro Dynamic Co. who manufactured them, or the cost of manufacturing them in quantity?

108 x-Q. I mean the cost of the manufacture or of making the exhibits produced severally.

A. I cannot tell you what the actual cost was. I can approximate closely our estimate of the cost of manufacture in quantity.

3832 109 x-Q. What would have been the cost, if a person having the electric current ready to apply thereto, should have given an order for 15 lamps of which 5 were to be like each of the 3 exhibits?

A. I cannot tell what royalty would have been charged on the lamps. I can tell what would have been the cost of the lamps if manufactured largely and showed the manufacturer a profit.

3833

110 x-Q. Please lay out of view the royalty, and then then answer the last question?

A. The long lamp adapted to the arch form of carbon, could have been manufactured and sold at a fair profit at a dollar and a half to a dollar and seventy-five cents. The same type of lamp but with straight pencil carbons would be the same or possibly seventy-five cents more. The lamp with the spiral conductors would cost from twenty-five cents to fifty cents more. In each of these lamps there would be a metal dia- 3834
phragm in lieu of the stone diaghragm in No. 1. The upper holder shown in the spiral conductor lamp would be modified and cheaper, as it is in some of the other exhibits. The feeder lamp would cost $10 or $12, possibly $15, and the profit would have to be got on that.

111 x-Q. Was it not the intention of Messrs. Sawyer and Man that the internal works of their lamps should, in case of the breaking or giving out of the carbon burner be susceptible of re-utilization without injury thereto, or without removing the same, or other parts 3835
of the lamp?

A. It was our intention to make our lamps so that if the incandescent conductor should give out, the lamps could be opened and a new conductor put in.

112 x-Q. Could this intention have been affected if only glass globes sealed at the bottom had been made?

A. We did use pear-shaped glass globes and other shapes, although I have none of them to exhibit, but these lamps were made of two pieces of glass separable from one another but sealed to each other. If they 3836
had been fused to each other they could not have been taken apart and a new carbon put in without breaking the globe of the lamp, except in the case of one kind of lamp which we made but never patented the globe of, which was of one piece of glass, and in which an arrangement was made for putting a new straight pencil of carbon into the lamp through one of its binding screws in case the carbon was broken.

3837 By sealed together I mean accurately ground together air-tight and the junction covered with some kind of sealing material. I do not know that this covering of the joint with this sealing material was necessary, but we practiced it ordinarily.

113 x-Q. You have spoken on direct of the resistance of the carbon burners of the Sawyer and Man lamps. In what month and year and by whom was such resistance measured, and were written memoranda kept thereof?

3838 A. The resistances were measured during all the time that Mr. Sawyer and I were together, except the first few days, a week or two, by Mr. Sawyer, and after Mr. Myers came with us, by him and Mr. Myers. I do not think the resistances of all the lamps were accurately measured, but records were kept of such measurements as were made, and we made calculations based on them in regard to the cost of distribution when using lamps of different resistance and different arrangement of lamps in circuit. My
3839 knowledge of these resistances was derived from these memoranda and from being present sometimes when these resistances were being measured. I do not know where these memoranda are.

114 x-Q. Please state the consideration for the three transfers, whether cash or stock of the respective companies, and if the latter, and you received any thereof, or know what dividends were declared on such stock?

A. In each of the transfers I think both cash and stock of the transferee was paid. I received stock
3840 and the cash that I had expended for the first transfer to The Electric Dynamic Light Co. Mr. Sawyer received stock and cash. I know that the Electro Dynamic Light Co. received from the Eastern Electric Manufacturing Co. some cash and some stock of that company, the same was the case when the transfer was made to the Consolidated Electric Light Co. A divi-

dend was made of part of the stock of The Eastern 3841
Electric Manufacturing Co., received by The Electro Dynamic Light Co., the balance was used to redeem certificates payable out of profits or convertible after a certain time into stock. The Eastern Electric Manufacturing Co. made a dividend of part of The Consolidated Electric Co.'s stock of which I got some. I cannot give the details of the amounts, how much I received, or how much Mr. Sawyer received. I think
that all the stock of The Electro Dynamic Co. was is- 3842
sued to Mr. Sawyer and myself in payment of the patents and immediately transferred by us to the subscribers for stock, of whom we were two, in the usual way.

ALBON MAN.

Adjourned to Friday, January 24, 1890, at 2 o'clock P. M.

3845

COMPLAINANT'S EXHIBIT [MC KEESPORT CASE] CHEEVER AGREEMENT.—W. T. F., S. E.

Marked in this case:

DEFENDANT'S EXHIBIT CHEEVER AGREEMENT.

AGREEMENT made by and between the Electro-Dynamic Light Company, organized under the laws of
4846 the State of New York, and having its principal place of business in New York City, party hereto of the first part, and Charles A. Cheever, of the City, County and State of New York, party hereto of the second part:

Witnesseth, that whereas, the party of the first part is the owner of a certain improvement in Electric Lights or Lamps, consisting in the use of an incandescing arc of carbon, the joint invention of William E. Sawyer and Albon Man.

And whereas, the party of the second part is desirous
3847 of acquiring the ownership and control of said invention for the United States and of any Letters Patent of the United States granted therefor; to which end he desires time in which to negotiate with other parties in relation to the purchase of said invention and patent for the common benefit of the parties hereto:

Now, therefore, in consideration of the premises and of other good and valuable considerations, them thereunto moving, it is agreed and covenanted between the parties hereto as follows:

3848 1. The party of the second part shall have the right or option of purchasing said invention, as described and claimed in that application, this day prepared and executed, and shown in the models and drawings thereof, and in any Letters Patent which may hereafter be granted in the United States therefor, thereon for the sum of One Hundred Thousand Dollars in cash, during the coming week, ending at midnight of Saturday, January Seventeenth, Eighteen Hundred and Eighty.

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2. The expense of preparing and soliciting the patent herein referred to, is to be borne by the party of the second part, as far as incurred during the existence of this option. In case he fails to purchase, he is to be liable for no further expense, but in case of a consummation of the purchase, all further expenses, costs, and charges are to be borne by the party of the second part.

3. It is understood between the parties hereto that said party of the second part will complete his nego- 3850
tiations at the earliest practicable moment; but in case delays should occur, if matters are in such condition that further time can be given to complete such negotiations, without loss to the party of the first part, or complications of its affairs, such time may be given by mutual consent.

CHAS. A. CHEEVER.

Dated January 9th, 1880.

Witness to C. A. C.: 3851
W. K. Applebaugh.
William D. Baldwin.

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3853

COMPLAINANT'S EXHIBIT [MC KEESPORT CASE] LOWREY LETTER OF OCTOBER 30, 1878; MARCH 26, 1889. W. T. F., S. E.

Marked in this case:

DEFENDANT'S EXHIBIT LOWREY LETTER OF OCTOBER 30, 1878.

3854 JOHN K. PORTER, GROSVENOR P. LOWREY, GEO. WALES SOREN, CH. FRANCIS STONE, GEORGE S. HAMLIN, P. O. Box 1836.

Porter, Lowrey, Soren & Stone, Attorneys and Counsellors at Law. No. 3 Broad Street, Drexel Building.

NEW YORK, October 30th, 1878.

DEAR SIR:—

Referring to my visit to 94 Walker street this morning, I think it desirable to repeat to you more deliberately than may be done in a hurried conversation that the field of electricity is so vast, and promises such
3855 great results, that good business men would commit a great error if they should allow themselves to become, in the outset, involved in any uncalled for struggle for the possession of the whole field, and a small part of it would be enough for all.

As I said to you this morning, the suggestions which passed between us, arising apparently in both our minds out of the same practical considerations, were not intended by me to express the opinion of my
3856 associates, for I had not seen any of them since reading in the morning paper the announcement of the Sawyer-Man-Light; nor do I understand what you said as in any way committing you, except to the general proposition that it was always in these matters wiser to unite strong parties than to divide them, and leave them to expend themselves in opposition.

I want to repeat, therefore, that I shall be at all

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times in favor of considering more carefully the general ideas which we mutually expressed, and that without any very great reference to the question, who would or would not succeed in the final contest.

As I understand it, you have not a correct idea of Mr. Edison's light; in fact, he has not allowed anyone to know what his intention consists of, but I understand that you have what is apparently to me a very good light, and even if we were able to sustain both 3858
rival patents we should be competitors in business, which itself would be commercially a great mistake.

I have already described to one of the Directors of our Company what I saw of your light, and I shall mention our conversation to others as I shall chance to meet them.

You will be glad to hear that a telegram from Menlo Park this morning informed me that Mr. Edison slept twelve hours last night without pain, and is therefore out of the difficulty which has prevented him from 3859
working for the last few days.

I presume that your foreign patents are taken out, and I think there is a much greater field over there than here, and also if there should be a practical union of these interests in any way, it would be enormously to the advantage of both, on the other side, to be represented by the same strong banking house or houses.

Very truly yours,

[SD.] G. P. LOWREY.

ALBON MAN, Esq., 94 Walker strset, city. 3860

3861

COMPLAINANT'S EXHIBIT [MCKEESPORT CASE] MAN'S LETTER TO LOWREY OF OCTOBER 31, 1878.

. W. T. F., S. E.

Marked in this case:

DEFENDANT'S EXHIBIT, MAN'S LETTER TO LOWREY OF OCTOBER 31, 1878.

NEW YORK, October 31, 1878.

3862 DEAR SIR:

I have to acknowledge the receipt this afternoon of your letter to me of October 30th inst. We feel very confident of the success of our inventions and the stability of our patents. Some of your people, and if we are not mistaken, from Mr. Edison's own laboratory, have seen our light and can attest its excellence, as can also a vast number of people who have thronged to see it. Of course we have not made public all that we have
3863 done, nor do we suppose that Mr. Edison has done so, but we do distinctly claim that we are the inventors of all that we use, and that we can show our priority over Mr. Edison and every one else in these inventions, and we cannot but feel from what we see published that many of these inventions are essential to the successful working of Mr. Edison's light.

If we are right, Mr. Edison's light, if put in operation, must in the end pay tribute to us. At the same time, my dear sir, we do not claim to be all the world
3864 nor to contain all the wisdom of it, nor to know in advance all that has been and will be found out about lighting by electricity. Permit me just here to pay what is but just tribute to the ability, skill and inventive talent of Mr. Edison, and to admit that his well-known character in this respect is a great advantage to those attempting to bring his invention before a public, whose confidence in him as an inventor is

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great. I admit, at the same time, the high character, standing and wealth of your associates, as you must that of those who are associated with us. I do not permit myself for a moment to think that either you, or those associated with you, would think of attempting to deprive us by litigation or otherwise of our just rights notwithstanding any inference to the contrary that might be drawn from your letter. Having thus cleared the ground, I have to say that I can see no ground of objection to a union of interests that 3866
should do away with antagonism, if a fair basis for such union can be found. But on the contrary I can see, and I have no doubt the eminent business men who are associated with us in interest would also see, that great advantage might be derived to both companies from such a union.

If you will bring about the appointment of a proper committee from your company for the purpose, I will see to it that representatives from our company shall meet them as soon as you advise me, for the discussion 3867
of the subject. The matter may be informal if you desire it, at first.

I am happy to hear of Mr. Edison's improved health.

In the matter of foreign patents I believe we are all right.

Very respectfully yours,

ALBON MAN.

G. P. LOWREY, ESQ.,

Drexel Building, cor. Wall and Broad streets, N. Y. 3868

3869

COMPLAINANT'S EXHIBIT [MCKEESPORT CASE] LOWREY LETTER OF NOVEMBER 6, 1878. MARCH 29, 1889.

W. T. F., S. E.

Marked in this Case:

DEFENDANT'S EXHIBIT LOWREY LETTER OF NOVEMBER 6, 1878.

3870 JOHN K. PORTER, GROSVENOR P. LOWREY, GEO. WALES SOREN, CH. FRANCIS STONE, GEORGE S. HAMLIN, P. O. Box 1836.

Porter, Lowrey, Soren & Stone. Attorneys and Counsellors at Law, No. 3 Broad St., Drexel Building.

NEW YORK, Nov. 6th, 1878.

DEAR SIR:—

I received your letter of Oct. 31 inst. as I was leaving my office. I had time to glance at the first page
3871 of it, hastily, and then, thinking I might not have another opportunity for several days, I dictated to my stenographer my letter to you of November 2d and left it to be written out and signed by him for me. I have just this morning returned to the city and take the first opportunity to make a more formal reply.

I adhere to the general ideas of policy which I expressed to you in conversation and in my former letter. I do not think the matter is in any situation, however, to require the present consideration of
3872 whether or not we are likely to be rivals, and as such, injurious to each other. The time may very likely come, and perhaps soon, and of one of those interested in Mr. Edison's patents, I shall be ready and disposed towards whatever may seem to be required by good business judgment.

I should not allude to any possible contest between our patents, except from your having expressed a belief (very proper from your standpoint) that "Mr. Edison's light, if put in operation, must in the end pay a tribute" to you.

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I am entirely satisfied that the most exhaustive search of what has been done by others will show that Mr. Edison has produced a perfectly novel invention.

Very truly yours,

G. P. LOWREY.

ALBON MAN, ESQ., 3 Mercer St., City. 3874

3877

COMPLAINANT'S EXHIBIT [MCKEESPORT CASE] SAWYER'S LETTER, DATED MARCH 7, 1878, MARCH 27, 1889.
W. T. F., S. E.

Marked in this case:

DEFENDANT'S EXHIBIT SAWYER'S LETTER, DATED MARCH 7, 1878.

3878

OFFICE OF
THE UNITED STATES ELECTRIC ENGINE CO.,
(74 & 75 Coal and Iron Exchange) 21 Cortlandt St.,

NEW YORK, Mar. 7, 1878.

DEAR SIR: I received your note too late to see you yesterday, having been very busy running around all day. Before receiving it I had made an important appointment for this morning, and could not therefore
3879 come round to-day.

There is no machine at Columbia College, but I have got hold of a Hochausen machine that answers the purpose. Shall have it all this week, but not next week. I have hired a room, this morning, at 43 Centre street, up one flight, and the wires are now being run. Expect to do something this afternoon. If you can come round between 2 and 4, I will meet you there. Ask the engineer in the basement for my location. The entrance is by an arched way from Centre street.

3880 The difficulty seems to be vanquished, although the machine is not just what we want.

I tried the full power on a lamp yesterday, and you would have supposed a small sun was shining in the vicinity.

Truly yours, in haste,

W. E. SAWYER.

3881

COMPLAINANT'S EXHIBIT [MCKEESPORT CASE] LOWREY LETTER OF NOV. 2, 1878. MARCH 29, 1889,
W. T. F., S. E.

Marked in this case:

DEFENDANT'S EXHIBIT LOWREY LETTER OF NOV. 2, 1878.

3882

NEW YORK, Nov. 2, 1878.

DEAR SIR: I have this moment received your letter, which, however, I have not time to read, as I am going out.

I was surprised this morning to hear that my letter to you was spoken of as an advance towards a consolidation of our company with yours. I am sure you cannot have made such a mistake. At any rate, if such an impression was derived from what I wrote, 3883
there was no such specific purpose in my mind, and I desire to correct it now and to add that I have not the slightest idea that the Edison Electric Light Co. would entertain any such proposition from you, and certainly they would not make it.

It is one of the dangers of private intercourse that it is liable to these misconstructions.

Very truly,

G. P. LOWREY,

by k. 3884

ALBON MAN, Esq.,
94 Walker St.

3885

Testimony of William E. Sawyer in the McKeesport Case. Copied from Sawyer-Man vs. Edison Interference Record.

William E. Sawyer, a witness produced on behalf of Sawyer and Man, being duly sworn and interrogated by Mr. Broadnax, testifies as follows:

1 Q. What is your name, age, residence and occupation?

3886 A. My name is William E. Sawyer; my age 31 years; my residence is Hotel Devonshire; my occupation is an electrician.

2 Q. Please state whether you are the Wm. E. Sawyer, one of the parties to this interference?

A. I am.

3 Q. The subject-matter of this interference, as given by the Patent Office, is: "The Incandescent Conductor for an Electric Lamp formed of carbonized paper;" please state whether or not you, in conjunction with
3887 Albon Man, have at any time made and used such a conductor?

A. We have; a great many times.

4 Q. State, as near as you can recollect, when it was that you and Mr. Man first made such a conductor?

A. Almost immediately after we went to 43 Centre street; should think about the sixth or seventh of March, 1878; might have been a little earlier or later.

5 Q. Give the circumstances that gave birth to that
3888 invention?

A. Before I became associated with Mr. Man I was associated with a Mr. James Flannagan at the Coal and Iron Exchange, where I made a number of experiments in electric lights; I had a theory that the most perfect incandescent lamp would be one having the highest resistance and the least transverse mass, and I filed an application in the

3889

Patent Office for a chalk or some similar material held between two conductors, and containing in a little groove, running across from conductor to conductor, a powdered graphite or carbon to carry out this idea; I don't remember the exact wording of the specification, but the patent was never granted, but is probably on file in the Patent Office now; I spoke to Mr. Man of this idea, and sat down at my desk, 43 Centre street, and drew pencil marks on some ordinary foolscap writing paper, rather heavy, 3890
and I took two small copper wires and held them with my fingers on that while the degenerators were running; when he brought the wires very close together we could only get a little spark; then Mr. Man and I went around to a place where they deal in pure graphite, and got some samples; I'm not exactly sure what kind of paper we used, but think we laid the same kind of a piece of paper, or piece of blotting-paper, and drew a heavy line with a pencil so as to make a creasing; then we filled the crease with pow- 3891
dered graphite and then brushed it off of the top so as to leave only what was in the crease; we had some trouble getting the current through that, but when we succeeded we charred or burnt the paper; I recollect that in looking at that I suggested to Mr. Man the charred parts that were left were so fine that it would probably make a good carbon; Mr. Man then took a piece of blotting-paper; at first they were simply straight strips one-eighth to three-sixteenths in width and one-half to perhaps 1 inch in length. Mr. Man 3892
worked over them, rubbing and pounding them with graphite till he got them full of it. But the resistance was higher than what we had laid in the crease of the paper, and it was some time before we succeeded in making the current go throught it. Of course this destroyed the paper. Am not sure at whose suggestion, but to prevent that we put the strip in a sealed globe

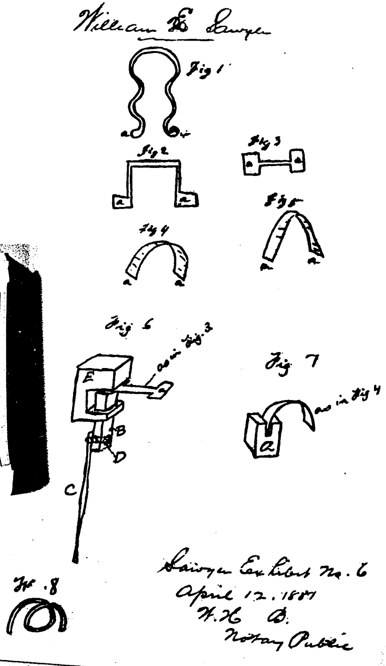
3893 filled with ordinary illuminating gas. I should not think it took over a minute to carbonize them. That blackened the globes. We treated those carbons in globes, *i. e.*, we passed the current through the carbons while a stream of illuminating gas was flowing through the globes. We concluded that that was a rather expensive way of making carbons. Concluded that the best way to do it was to burn it out, the way as we done in carbonizing any material. We had no facilities there, there being neither a stove nor a furnace. Mr.
3894 Man and father hunted around, found two old pieces of thick cast iron. One looked as it might have been the foot of some heavy piece of furniture or machinery. Had a hollow in it The other, if I recollect rightly, was merely a flat piece of iron. Wë cut out pieces of blotting-paper, and I believe an old drawing we had. Mr. Man packed them into that with some common powdered gas retort carbon which he got from Charles T. Chester in Centre street. Mr. Man took the box home (should say the made-up trap), and brought it
3895 over the next morning with the paper carbonized. I would take those, treating them and putting them in lamps. Most of the experimenting after that was done by Mr. Man himself. My own idea was that a much harder carbon would be better than those thin, fragile paper carbons, but Mr. Man preferred the paper. I think he does till this day.

6 Q. After you had the paper carbons made, state whether you treated them electrically in the presence of hydro-carbon for the purpose of consolidating and
3896 enlarging them.

A. Yes, I did.

7 Q. In making the carbons of the form you wanted them to use in your lamps, did you do that before or after the paper was carbonized?

A. Almost entirely before. When we wanted to expose the broadside to the light we had to cut them out



3897
before, but when exposed edgewise we could bend them after they were carbonized.

8 Q. Of what form did you make the burners of carbonized papers?

A. Generally in the form of a half circle or circle, but experimented, with all conceivable shapes. Anything that would suggest itself as capable of allowing for the expansion and contraction of carbon.

9 Q. Can't you specify some of the different forms besides a circle and a half circle? 3898

A. We also used a straight piece; a V-shaped piece. The sketches which I hand you represent some of the forms of carbon which we made of paper. (Witness makes a sketch.)

Sketches offered in evidence as part of the witness' testimony, and is marked Sawyer Exhibit No. 6, April 12, 1881, W. H. B., Notary Public.

3899
10 Q. Referring to this sketch you have made, state whether the letter "a" represents the enlarged part of the carbon that was used to hold the burner by in the supporting conductors?

A. It does in Figs. 1, 2 and 3; in the others it does not.

11 Q. How were the carbons represented in Figs. 4 and 5 held in the connecting conductors?

A. By clamping the ends; frequently we slit the ends of the conductors, which were sometimes of carbon and sometimes of metal. 3900

12 Q. Do Figs. 1, 2 and 3 represent a side elevation of the carbon held in the lamp, and the others a kind of perspective.

A. Figs. 1 and 2 represent a side elevation; Fig. 3 was made with the flat side up, as shown in Fig. 6, in which "b" is an oblong square piece of carbon,

3901 screwed to metallic upright "c" by screw "d"; "e" is a piece of carbon cut in the shape shown, with a square slot through the lower jaw, through which an oblong carbon, "d," passes. The connection with the carbonized incandescent part was made by the pressure of the weight of "e" on "b."

13 Q. Fig. 6, as I understand you, represents but one conductor, and one side of the connection between the conductor and the carbon section?

3902 A. Yes; the other end of the incandescent conductor was held in precisely the same way, object was to get a very light though sure contact; the carbon shown in Figures 4 and 5 were held as shown in Figure 7; in some, made in that form I think, my father made a square cavity, which was packed with powdered carbon after the burner was put in; some of them were held as shown by the drawing Sawyer Exhibit No. 5; the wire shown in the bottom of the clamp, Figure 4, was only used occasionally when the carbon was thin and
3903 the clamp imperfect in shape to bring the clamp up against the carbon burner.

14 Q. Does this drawing, Sawyer Exhibit No. 4, represent the lamp substantially in which you used those paper carbon burners?

A. That represents the lamps as finally used, but it was only one of the many forms of lamps we used; and it particularly represents one of the lamps I took down at 94 Walker street, in the winter of '79-'80, to give to a friend of mine, Mr. Arnoux, of Arnoux &
3904 Hochhausen, on the Monday morning after the announcement of Mr. Edison's discovery, to show to him that we had previously invented that; this was, I think, on the 20th of December, 1879, that the Herald published that account about Edison; as soon as I got to my shop on Monday morning, which was about nine o'clock, I took this lamp to Mr. Arnoux, and requested him to hand it to Mr. Shanks of the

Tribune, to keep as an evidence that Mr. Edison was 3905
not the original inventor—to satisfy him: and I did it thus early that it could not be said that we possibly could have had time to manufacture it after Edison's announcement; this lamp was taken down in January or February of the same year, eleven months previous, having been broken; it might have been as early as December, 1878; Mr. Lawrence Myers saw this lamp in operation, and I think, saw it broken; it was taken down, I know, during Mr. Myers' stay there. 3906

15 Q. Referring now to the paper carbons, some of which are represented in the sketch Sawyer Exhibit No. 6, state whether or not you put them in a sealed lamp and tested their practicability?

A. Yes, sir; we did.

16 Q. Did you try any of the carbons illustrated by the drawing, Sawyer Exhibit No. 6, and, if so, which of them?

A. The carbons shown in Figures 1, 2 and 3, and the half circle, were positively used; were sealed up 3907
and run; the great trouble with them was when we raised the temperature till we could get a bright light they would break; for this reason I preferred the harder carbons; we finally made them hard enough by treating them in hydro-carbon gas by the Sawyer-Man process.

17 Q. How long did they last in the lamp?

A. Untreated by the Sawyer-Man process would last from one second to ten minutes, if run up to give a good bright light; if run at a low temperature, they would run anywhere from an hour to one hundred 3908
hours; it depends entirely upon the temperature.

18 Q. State, as near as you can recollect, how long the best of the paper carbons you made at 43 Centre street would last in the lamp when raised to a temperature high enough to give a good bright light, after having been treated by the Sawyer-Man process?

A. Run at a power of about 25 candles they would

3909 last from 5 to 100 hours; once in a while we could get a lamp so perfect in every respect that it would seem to undergo no change after a long use; but generally they would fracture in from 5 to 20 hours, run at that temperature; the difference in the duration of the burners was due to both imperfections in the lamp and in the carbon; where the fracture alone occurs it must be due either to imperfection in the carbon or the effect of unequal expansions; when consumption
3910 occurs it is due to the imperfect charging of the lamp.

19 Q. State, as near as you can recollect, about how long you and Mr. Man continued your experiments at 43 Centre street?

A. Should think about two months; all the time we were there.

30 Q. After you got through there, did you resume your experiments at any other place?

A. We moved from there to 2 Howard street, where I don't think we made any experiments on lamps, not
3911 having facilities for such experiments; we then moved in the fall of the year to 94 Walker street; I have got memoranda to show all these things; we moved to 94 Walker street during the 18th and 19th of October, 1878.

21 Q. State what, if any, experiments you made with carbonized paper carbons at 94 Walker street?

A. We employed an assistant who is dead now (Edwin L. Myers), and Mr. Man and I divided our work. Mr. Man experimenting with carbons and
3912 partly assisted by Mr. Myers; Mr. Myers conducting the charging of the lamps, and myself designing the different apparatuses connected with the lamps, such as switches, dynamo-machines and electrical measurements, etc., etc. I knew that Mr. Man continued carbonizing paper and live willow twigs and a good deal of such work generally; but I took no active part in it myself. He made the carbons and I used them. I

don't think I ever did another thing in the manufac- 3913
ture of those carbons after I came in Walker street. We divided up our work and I had a general knowledge of what was going on. Almost every day Mr. Man would have some new carbons to offer. Made a good many by taking artist crayon (called the French willow carbon). He carbonized all kinds of woods. Mr. Lawrence . yers brought him in, I think, a willow twig which he carbonized. Among other forms of carbon Mr. Man made one of a willow twig like Fig. 8, Sawyer Exhibit No. 6. What Mr. Man did not do 3914
in carbonizing different things can't be imagined for he did nothing else but work on that about all the time.

22 Q. Please state whether or not you began and perfected the invention of the paper carbon burners while you and Mr. Man were at 43 Centre street?

A. Yes, sir.

23 Q. State as near as you can recollect when it was, while you were at 43 Centre street, that you got the invention of the carbonized paper burner perfected? 3915

A. It was within two or three weeks after we got in 43 Centre street.

April 13, 1881.

Par ies met pursuant to adjournment.

Same counsel present as before. 3916

Cross-examination of WM. E. SAWYER by GEO. W. DYER, ESQ., of counsel for MR. EDISON:

24 x-Q. Can you give the date when you moved to 43 Centre street?

A. About the first of March, 1878.

3917 25 x-Q. Who were the premises hired from?

A. From the engineer of the building. Am not positive; think his name was Porter.

26 x-Q. What power did you use in that building in your experiments?

A. The regular power furnished to the building was shafting motion in the shop when I took it.

27 x-Q. What kind of electrical engine did you see at that place?

3918 A. Had several engines there; Arnoux & Hochhausen had put one of their machines for electric lighting down in the engine-room, and they gave us permission to run wire from the shop down into the engine-room; then, afterwards, I had a Hochhausen electro-plating machine, which I bought, and another Hochhausen machine like the plating machine, but wound with a fine wire, which I borrowed; then there were two or three machines set in there for us to try; I think all of those were Weston machines (electro-plating) but we
3919 could not do anything with these Weston machines.

28 x-Q. What was the electric power or capacity of each of these Arnoux & Hochhausen machines?

A. The light machine in the engine-room had a high electro-motive force, comparatively had, I should judge, two ohms internal resistance; I never measured this, but judge from another machine of the same make which I now have; that was the very first machine of that design which Arnoux & Hochhausen ever made; when put in there it was incomplete; they
3920 put it in for trial, to satisfy themselves of its capabilities; I think this machine was about equal to the intermediate size which they were making a year or two ago; I don't think they make just such a machine now; they said that the machine gave a light by the arc of 20,000 candles, but I should judge it only gave about 5,000 candles; the plating machine had a low electro-motive force; I don't think had more than one-half

ohm's resistance; would give no voltaic arc at all; 3921
was driven at 1,500 revolutions a minute; the third machine was charged up by the plating machine; the armature was wound with fine wire, a d was driven at a speed of about 4,000 revolutions a minute: only the armature coil being connected with the lamps; nothing is to be said about the Weston machines; could not do anything with them; I mean they did not have electro-motive force enough to overcome the resistance of the lamps. 3922

29 x-Q. How long did you occupy that shop?

A. I went from there to Washington, and gave it up, after being there two months and not over three; should think about two months—perhaps three months.

30 x-Q. What force did you have in that shop?

A. Nobody employed in the shop but my father, William Sawyer, we had work done outside; we had some of the mechanical parts of the lamps made outside to save time in the shop; not very much done outside of the shop. 3923

31 x-Q. By whom was this outside mechanical work done?

A. Is difficult to answer; my father would have it attended to; one man in the same building did a good deal of it; Pearce & Jones, of William street, did some work; generally, father would go in some shop, take a man off his work, and put him on a little job; I can't tell you the date Pearce & Jones did work; it was while I was with Mr. Man; I get it from an account with Mr. Man, in which the dates do not appear; I 3924
think it was about the time we were in this shop—while I was first associated with Mr. Man.

32 x-Q. In your answer to the fifth question you say, "I had a theory that the most perfect incandescent lamp would be one having the highest resistance and the least transverse mass;" what effort did you ever make to develop that theory, and when?

3925 A. The first effort was in an application for a patent the idea of which was a thin layer of powdered carbon on a refractory base. (Witness here makes a sketch which is made a part of his evidence, marked Sawyer Exhibit 7, April 13th, 1881, W. H. B., and proceeds as follows:)

Fig. 1 is a top view. Fig. 2 a side view. A is refractory base and a narrow groove running along the top opening in an enlarged space at the ends up into
3926 which the two conductors B B come. The carbon (powdered) was laid in the groove and packed in the end space; this may not be exactly in the form of the application but is substantially the same. This was a frequent subject of conversation—with some other applications I put in with Mr. Man.

33 x-Q. Was this application to which you refer first in your own name or was Mr. Man associated with you?

A. Was in my own name—made some time before I
3927 knew Mr. Man. Think the application was not made earlier than October, 1877, and not later than January, 1878; I was continually filing applications, and as this was rejected it cleared my desk of all record of it.

34 x-Q. What become of this application?

A. Was rejected and don't recollect the grounds.

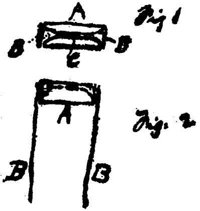
35 x-Q. Have you made any effort to amend it or keep it alive?

A. Undoubtedly it was amended but I don't recollect what was done about it. Probably I considered
3928 the Examiner's objection as good.

36 x-Q. Did you prepare that application yourself?

A. I did.

Counsel for Edison gives notice that the production of this application will be required at the hearing of this interference.



Sawyer Exhibit 7.
April 13. 1881
W. H. B.
Notary Public

3929

37 x-Q. What other effort did you make to develop the theory inquired of in 31 x-Q.

A. The effort to develop that theory and put it in practice was made with Mr. Man at 43 Centre street.

38 x-Q. Has that theory ever been stated in any of your patents for electric lights or in those of Sawyer-Man?

A. I can't recollect whether it has been stated or not in any of the patents.

39 x-Q. In another portion of your fifth answer you 3930
speak of carbonizing paper in what you call a "made up trap," in which you packed the paper with "powdered gas retort carbon;" what effect would that carbon have upon the paper?

A. No effect whatever. The carbon which was sold by Mr. Chester was purified carbon, which he sold at about $1 per pound. It was used to surround the paper and protect it from the air; more for this than any other purpose.

40 x-Q. What effect did the subsequent treatment of 3931
these carbons, in the presence of hydro-carbons, have upon the carbons themselves. I refer to the 6th Q. and Ans?

A. Two quite different effects. In some cases the whole mass of the original carbon would be hardened, and become homogeneous with the further deposit. In other cases the original carbon would remain unchanged and the deposit carbon could perhaps be broken off from it. This was due probably to difference in the
manipulation. It the original carbon was heated up 3932
so as to drive out occluded gases, but not sufficient to decompose the hydro-carbon surrounding it, its pores will become permeated by the hydro-carbon which a quick impulse of current will decompose in the mass of the carbon, thus hardening it, and so on. But if the carbon is heated so hot as to decompose the surrounding hydro-carbon in the first place, then the original

3933 carbon will remain unchanged. By combining the two processes the original and deposit carbon may be made one and substantially the same.

41 x-Q. What effect did this treatment have upon the resistance of the carbon conductors?

A. Would reduce the resistance in proportion to the extent of the treatment.

42 x-Q. As a matter of fact, about how much was the resistance reduced?

A. Mr. Man's idea and mine upon that question of
3934 resistance began to differ; that is to say, my theory that the most perfect electric lamp would be one in which the incandescent conductor had the highest resistance and the least transverse mass was gradually abandoned by myself, which largely retained by Mr. Man. My present theory being that the most perfect electric lamp is one in which the incandescent conductor has not only the least transverse mass, but the least resistance. I soon began to reduce the resistance of my carbons to as low as an ohm; at present I make
3935 them only one-quarter ohm; therefore, I would treat the carbons so as to obtain a heavy deposit. Judging from the difficulty in getting the current through some of Mr. Man's carbons treated according to his ideas, they must have had as high as 100 ohms' resistance, but I don't recollect whether we made measurements of any particular ones. Answering the question directly, I should say that Mr. Man reduced the resistance in his carbons from fifty to seventy-five per cent. by the treatment referred to. This is an estimate, and not the
3936 result of measurement.

43 x-Q. Did this diminution of resistance in the carbon conductors greatly increase the heat within the lamp?

A. Increased the heat, but not in proportion to the diminution of the resistance.

44 x-Q. Did this increased heat require the use, in

some of your patented lamps, of radiators to convey 3937
away the surface heat?

A. In some of them, but don't use them in my present lamps, as they will stand the heat without.

45 x-Q. Referring now to your answer to the 14 Q., and that part of it relating to the publication in the *Herald* of about December 20, 1879, did you make one or more replies to that article and publish them?

A. I believe something was said, but I don't recollect what now. 3938

46 x-Q. What newspapers did you publish the replies in?

A. I don't know any particular newspaper; I believe I wrote to several newspapers; I think the very day that account of Edison's was published I sent the same article to every newspaper in New York.

47 x-Q. Do you remember what newspapers published your article?

A. I think the *Sun* and the *Tribune*, or some other paper, but am not certain; I was continually writing 3939
to the papers; can't remember any particular article published in any particular paper.

48 x-Q. Did you subsequently, and in a short time, furnish one or more additional articles upon the same subject, which were published in the *Sun*?

A. Very likely I did. Refer to the previous answer with regard to my constantly writing to the newspapers.

49 x-Q. Referring now to your 17th answer, could a lamp, as described there, which would burn from one second to ten minutes, be used in competition with gas 3940
or other commercial lights?

A. It could not; and at that time the invention was not so perfected in all respects, including the enclosing globe and mechanism, as to make the lamp suitable for any practical purpose. By mechanism I mean the general construction of the lamp, method of sealing,

3941 conductors, etc. That is all the attachments of the lamp and the general mechanical construction of the lamp.

50 x-Q. Referring now to your 18th answer, could a lamp as described there, which would burn from 5 to 100 hours, be used in competition with gas or other commercial lights?

A. I think not.

51 x-Q. Have you ever produced an electric incandescent lamp, with a paper carbon conductor, which
3942 could be used in competion with gas or other commercial light?

A. We have produced a lamp of the kind described as capable of competing with gas as any other electric lamp produced with an incandescent paper carbon; I refer to heated carbons.

52 x-Q. When and where did you produce such a lamp?

A. At 94 Walker street, substantially the same as in Exhibit No. 4 (Sawyer Exhibit), referring to the copy
3943 of the drawing making part of the application for the patent. This was between the 20th October, 1878, to the 20 January, 1879. We had this lamp perfected before Mr. Lawrence Myers left.

53 x-Q. How long did any of the lamps referred to in the previous answer actually burn?

A. One or two of them burned I think about 100 hours. The majority of them would fracture in about five hours. Nineteen-twentieths of them would fracture in about twenty hours. That is, of course, run up to
3944 the temperature which would give about twenty-five candle light. That is about five times the light the Edison and Maxim lights were usually run at.

Re-direct examination by Mr. Broadnax:

54 R-d Q. Referring now to the lamps referred to in answer to x-Q 53, please state whether or no those

lamps are fitted with the same kind of paper carbons 3945
that you made at 43 Centre street?

A. Some of them were and some were treated with gas-retort carbon. Most of them were fitted with paper carbon. We were treating those lamps to get the greatest durability possible. The treatment was the same except we substituted liquid hydro-carbons for gaseous.

55 R-d Q. During your experiments at 43 Centre street, was William H. Church a frequent visitor
there? 3946

A. Yes.

56 R-d Q. Did he witness those experiments with a prospect of interest in the invention?

A. I can't say what experiments Mr. Church witnessed. He was there every day in and out. Don't remember what his prospect interests in inventions were.

W. E. SAWYER.

3947

New York, January 27th, 1890.

Met pursuant to adjournment. Present: Counsel as before.

It is stipulated and agreed that the deposition of Mr. Amos Broadnax, taken in the suit of the Consolidated
Electric Light Company vs. the McKeesport Light 3948
Company, in the Western District of Pennsylvania, which is printed on pages 86 to 188, inclusive, of Vol. 1 of the Complainant's Record in that suit, may be printed as a portion of the record in this case and read and used with the like effect as if such deposition had been duly taken in this suit, and the said Amos Broadnax, being duly called for further examination on

3949 behalf of the defendant's herein, being first duly sworn, and being interrogated by Mr. L. E. Curtis, testifies as follows:

1 Q. In your testimony in the McKeesport case, which has been stipulated into this case, you refer to the use in some of the Sawyer-Man lamps which you saw, of French pencils. What was the size of the French pencils which you saw so used in the lamps?

A. The French pencils, by which I mean French
3950 carbons, varied in size. Those that I saw used in the lamps would, upon my best recollection of the size at this time, vary from that of an ordinary knitting-kneedle to a large-sized knitting needle. I should say the smallest of them were as near the size of the carbons produced by Mr. Knowles and put in evidence in this case, as they could be. They varied in length, those that were in the lamps, I should say, from three-fourths of an inch to three-eights of an inch. I should say that the carbons after being treated by the Sawyer-
3951 Man process were about the size of these carbons produced by Mr. Knowles, the smallest of them. The largest would run up to the sixteenth of an inch in diameter and of about the same length that I have already given.

2 Q. These, I understand, were carbons you saw in use in the lamps in 1878, the time mentioned in your deposition in the other case?

A. Yes.

3 Q. How many of these small carbon pencils,
3952 about the size of those produced by Mr. Knowles, did you see and how much did you see them in use in the lamps?

A. I saw quite a number of them; how many I cannot state. I saw only a few lamps with them in, just how many lamps, I cannot state. I was there a number of times and saw these lamps with these small carbons in. Guessing at it from this time, I should

say I saw three or four of those lamps with those small carbons in. I mean the small French carbons. 3953

Cross-examination by Mr. Seward.

4 x-Q. You conducted the examination of the witness Albon Man in this case, as it has heretofore been taken, did you not?

A. I did.

5 x-Q. And in the course of that examination did he not produce and you put in evidence a box which 3954
contained two long carbons?

A. I did.

6 x-Q. Having those in your mind's eye, do you call those representatives of knitting needles of large size or small size?

A. I should say they were knitting needles of large size.

7 x-Q. Then they represent your idea of a knitting needle of large size?

A. Yes.

8 x-Q. And what is the difference in diameter between these large-sized knitting needles and the 3955
Knowles' productions?

Mr. Curtis: You mean the carbons produced by Knowles?

Mr. Seward: Yes.

A. I have not measured in units or parts of units, the size of either carbons referred to by you, and I cannot therefore state the difference in the diameters of the two carbons, but judging of their size 3956
from mere inspection of them, I should say that the carbons produced by Man were very nearly twice the diameter of those produced by Knowles.

9 x-Q. That is an expression of opinion, is it not, the correctness of which could be verified by any other person, including the Judge, by a comparison of the two carbons?

A. Certainly.

AMOS BROADNAX.

Testimony of Amos Broadnax in the Mc-Keesport Case.

Amos Broadnax, being called and duly sworn, testifies as follows:

1 Q. What is your name, age, residence and occupation?

A. My name is Amos Broadnax, I am 61 years of age, I reside at 41 Jefferson avenue, Brooklyn. I am a lawyer by profession, engaged more especially in the
3958 practice of the patent law, and have been since 1856, having had my office since 1862 in the City of New York, previous to that in Washington, and previous to that in St. Louis, Missouri.

2 Q. When, and under what circumstances, did you first see an incandescent electric lamp?

A. To the best of my recollection, I first saw an incandescent electric lamp in June or July, 1878. The circumstances which led to my seeing the lamp are these: I met Mr. Albon Man, some time in either of
3959 the months I have mentioned, on the corner of Nassau and Wall streets, in the City of New York, and he there told me about an electric lamp that he and Mr. William E. Sawyer had invented and made. He invited me to come up to his office, No. 3 Mercer street, in New York, and see the lamp. A few days after that I called at Mr. Man's office, No. 3 Mercer street, and he there showed me the lamp, taking it out of his safe and showing and explaining it to me. He, thereupon, invited me to go with him to
3960 No. 2 Howard street, on the corner of Centre street, N. Y., to the workshop of himself and Mr. Sawyer, and see the lamp illuminated. I went with him, and there and for the first time I met and was introduced to Mr. Wm. E. Sawyer. After a little talk about patents, the lamps and electric lighting, Mr. Sawyer put the lamp on the lighting circuit, that had its source in the shop of Arnoux & Hochhausen, and the lamp

was illuminated. 3961
Perhaps it will be proper to add in this connection, that I was at that time very well acquainted with Mr. Albon Man, having made his acquaintance in the latter part of the year 1868, and had obtained a number of patents for him or in which he was interested.

3 Q. Can you produce a lamp such as you saw at that time, and if so, please do it?

A. I have here in my possession an incandescent electric lamp, substantially such as was show to me by 3962
Mr. Man, at that time. This lamp, however, has not got the cup upon its base by which it was to be screwed on the fixture, as I think that lamp had. The lamp I am referring to is an exhibit in Case 3,472 between The Edison Electric Light Company and the Consolidated Electric Light Company, and also in Case 3,469 between the same parties, both in the Southern District of New York I have also a lamp in my possession which I now produce which is substantially the same lamp as the one last referred to, 3963
differing from it, however, in the manner of its sealing; otherwise, I don't think there is any substantial difference between the two lamps.

Said lamp is offered in evidence and marked "Complainant's Exhibit Broadnax, Sawyer-Man Lamp No. 1, November 28, 1888,"

4 Q. When, if ever, did you next see a Sawyer-Man incandescent lamp, and if so, under what circumstances? 3964

A. Some time in the fore part of October, 1878, Mr. Albon Man and William E. Sawyer came to my office and retained me as solicitor for the Electro-Dynamic Light Company, a New York corporation, more especially to take out some patents for improvements in incandescent electric lamps, the inventions of Sawyer and Man. I then again saw, within a few days after

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that, a number of their incandescent electric lamps, and I prepared applications for patents for the inventions, or a part of them, that were then brought to me, and drew an assignment dated October 14, 1878, of some of those inventions to the Electro-Dynamic Light Company, which assignment is in evidence in this case as complainant's "Exhibit Sawyer-Man assignment of October 14, 1878."

5 Q. Please describe the lamps you then saw?

A. I saw then, or about that time, say between Octo-
3966 ber 15 and November 15, at their works on the corner of Walker and Elm streets in New York, two practical types of lamps. The one type is illustrated in Patent 210,809, granted to Wm. E. Sawyer and Albon Man: the other is fairly illustrated, although not exactly so, in the drawing of the patent in suit; the principal difference between the two lamps being in the form and substance of their illuminants. In the one case, the illuminant was a straight pencil or filament of
3967 carbon, and in the other case, the illuminant was in the form substantially of the letter U. In this case the absolute continuity of the circuit was maintained, both ends of the illuminant being permanently connected to the leading-in conductors of the lamp. In the other case, I mean the case of the straight pencil or filament, only one end is fixed, that is, clamped to the leading-in conductor, the other end being held in contact with the conductor by means of a spring or weight.

3968 6 Q. Can you state what material the illuminants of these lamps was composed of?

A. The illuminants were composed of carbon in both cases; the straight carbons were composed of what is known as treated carbon, or pure deposit carbon, that is, carbon produced by treating the illuminant electrically in the presence of a hydro-carbon gas or fluid. In some cases the original pencils were made of some

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fibrous material cut to size, carbonized, and then treated as described in the patent to Sawyer and Man, 211,262, the fibrous part of the carbon being afterwards removed, leaving a straight shell either in the form of a tube, or in the form of a trough of pure deposit carbon. In the other case the carbon was made of paper cut to size and shape and then carbonized, and more or less treated by the process of the patent I have mentioned, and then put in the lamp. It must be understood, however, that in neither case did I see 3970
these carbons put into the lamp, but I frequently saw the carbons treated; I saw the blanks, in the case of paper, out of which they were made, and I saw these blanks after they were carbonized; that is to say, I saw blank illuminants taken out of the box in which they had been carbonized, and I saw them treated, but I don' remember that I ever saw any put in the lamp, but I saw the lamp with the carbons in them, and which I was told by both Sawyer and Man were the carbons about which I have been testifying, and I have 3971
every reason to believe, acting as I was, in a confidential relation to those gentlemen, that they were the same carbons that I had seen, as I have already stated.

7 Q. What do you mean by the expression, "put into the lamp"?

A. When I say "put into the lamp" I mean that I did not see the illuminant put in the lighting circuit, and the lighting circuit put in the lamp. In short, I did not see the lamp made, but did see the different 3972
parts of the lamp before they were assembled, and did see them after they were assembled, but did not see them being assembled. I saw these carbons, nevertheless, in the electric circuit while they were being treated and prepared for use in the lamp. I desire to add, also, that in the case of the straight pencil it was a common practice for them to make the illuminant

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by simply treating it slightly, preparatory to using it in the lamp, leaving the fibrous carbon intact as a part of the illuminant.

8 Q. State how often, and how many of these Sawyer-Man lamps with arch-shaped carbons made of paper or fibrous material you saw in use during the period from November, 1873, to December, 1879.

A. During the month of November, 1878, I saw a number of these lamps at the works of Sawyer and Man, or the Electro-Dynamic Light Co., rather, at the cor-
3974 ner of Walker and Elm streets; just how many, I cannot say. I have a very distinct recollection of seeing, in November, 1878, two of these lamps suspended from a chandelier hanging in the centre of the room, very brilliantly illuminated, and in addition to these central lamps there were, I think, either three or four, perhaps more, set in brackets around the room, of the same lamps. I saw these lamps there, I can't say now how many times, but quite often. Sometimes they would be illuminated and sometimes not, when I went there.
3975 It is impossible for me, after so much time has elapsed, to state how many times I saw those lamps, as well as other lamps.

9 Q. How did the lamps mentioned in your last answer operate when you saw them in use?

A. The practical operation of the lamps was perfect, so far as I was able to judge; I could see no defects in the operation of the lamps, nor did I hear of any. The luminosity of the lamps were very high, ranging, I should say, from thirty to fifty candle power. There
3976 was no brake in the operation of the lamps during the time I was there.

10 Q. How did their operation compare with the operation of the incandescent electric lamps in common commercial use at the present time?

A. As to that I can only testify as to their operation during the time that I saw them. During the time that I saw them their operation was as perfect as

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any lamp of to-day, that is, their light giving quality or power. Whether they were as economical as the lamps of to-day I don't know, but in so far as their function of giving a steady bright light is concerned, they were equal to any incandescent electric lamps I ever saw from that time to this.

11 Q. It seems to me that you have not fully answered my question 8, as to the number of these lamps that you saw. Please do so now?

A. I saw a number of lamps, as I have stated in
November, and I think also in December, 1878, and 3978
possibly in January, 1879, but as to January, I am not clear or certain of seeing any of these lamps in operation, but I think I saw some of these lamps in operation in November or December, 1879, at Mr. Sawyer's house in 54th street, I think it was 54th street, I am not certain as to the number of the street, but I think it was 54th street or in that neighborhood. Mr. Sawyer had a number of these Sawyer-Man lamps there on exhibition, and some of them I think were
these loop carbon lamps. As to the number of these 3979
lamps that I saw, I cannot tell how many of them I did see.

Adjourned till 2½ P. M.

Resumed after adjournment.

12 Q. Please describe the apparatus and operation of 3980
treating the fibrous material or blanks from which the illuminants were made, as far as you obtained knowledge of the same from seeing the apparatus and operation?

A. The apparatus used in treating these carbons, or rather a portion of it, I now produce. The apparatus as a whole consisted of a large lamp chamber. I mean

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by that the globe of a lamp which was made of glass. To
the bottom of that chamber a disc of glass was ground
and sealed. On the inside surface of this disc was
placed two electrodes, secured by tubular pieces of
metal passing through and sealed into the disc. The
two electrodes raised up above the disc side by side,
were some where about eight inches in length. The top
ends of these electrodes were connected to the bot-
tom side of a soap-stone disc through which two holes
3982 were bored, in which were inserted studs, the tops of
which were made in the form of clamps. In these
clamps the two ends of the carbon to be treated were
secured so as to complete the circuit in the lamp, the
clamping studs passing through the soap-stone
stone disc and uniting the conducter below the discs in
the circuit, the two conductors being of course sep-
arated and insulated from each other so as to make a
complete electric circuit. The globe of the apparatus
war filled with hydro-carbon gas or fluid. I think gas
3983 was used when I saw it in operation. The electric cir-
cuit was then connected to the tubes, and the current
sent through the carbon while it was immersed in the
gas, and was continued until the carbon was treated to
the degree required, the carbon being raised electric-
ally to high incandescence. The globe of the appa-
ratus I have not got, but I have got the glass dics with
the two electrodes set thereon united to the soap-stone
disc and the clamping studs, and I now produce it.

13 Q. Please describe the apparatus and operation
3984 of carbonizing the fibrous material or blanks from
which the illuminants were made, as far as you ob-
tained knowledge of the same from seeing the appa-
ratus and operation?

A. I do not know that I can describe with much
minuteness the retort in which the carbons were made.
I mean, of course, the paper carbonized, but a general
description of it is this: It consisted of [an iron or

3985
clay re ort, as I should judge, about four inches long
and two inches or perhaps two and a half inches in
diameter. This retort was taken out of the furnace of
the steam boiler used to drive the machinery in the
Walker and Elm streets shop. It was quite hot when
I first saw it, or when it was brought into the exhibi-
tion room, and it was allowed to cool down there suffi-
ciently to enable them to open it. I think Mr. Wm.
Sawyer (Mr. Wm. E. Sawyer's father), who was em-
ployed there, and who was a machinist by trade, 3986
opened it. After he opened it, he called my attention
to it. He said: "Here, Mr. Broadnax, you can see
what these carbons are like." I went to him and to-
gether we looked at them, he taking them out with a
piece of wire and showing them to me. I did not see
the paper blanks put in the retort, but I understood
from him that the retort was first charged with a layer
of powdered carbon, which was pressed down to a
smooth surface upon which the material to be carbon-
ized was laid. This material was covered over with a 3987
layer of powdered carbon, and pressed down as in the
first instance. Another course or layer of the material
to be carbonized was then put in the retort, and an-
other layer of carbon was put in and so on till the
retort was full. It was then covered with a lid, which
was then fastened. Just how it was fastened I cannot
tell, as I did not observe the thing in detail especially.
What I was interested in most was to see the carbons
as they appeared when they came out of the box.
Some of the carbons when they came out were quite 3988
hard, dense, smooth and strong. Some of them were
soft and only partially carbonized, and as I should say,
scarcely fit for use, but they were sufficiently carbon-
ized, as Mr. Sawyer explained to me, to enable him to
get a current through them in the treating apparatus.
I think old Mr. Sawyer told me in reponse to my ques-
tion as to how hot he had made the retort in which

3989 the carbons were contained, that they had heated it up as high as they could in the furnace of the boiler, and then put it in the ash pit and covered it with ashes until it was cooled down to the condition it was when he brought it in, which was scarcely a dull red heat. Some parts of it were not red hot. I recollect asking him if he could get heat enough in the boiler furnace to make perfect carbonziation. He replied that he did not, and that that would account for the imperfect conditions of some of the carbons.

3990 14 Q. State how these paper carbons compared with those you saw in the lamp, in apparaance?

A. They were the same in appearance, but there was a great variety of shapes.

15 Q. Please state what these great varieties of shapes were?

A. Some of them were straight pieces of carbon, slips or filaments cut from drawing paper, I should say. I say that, because the pieces that I saw that were not carbonized, were pieces cut from drawing paper. Some
3991 of them were in the form of a circular washer, a complete ring having a small section broken out; some of them were in the form of a bow or loop of irregular form, like that shown in the sketch I now make and produce.

> Said sketch is offered in evidence and marked "Complainant's Exhibit Broadnax Sketch, Nov. 28, 1878."

3992 16 Q. Did you see any lamps at that time, viz.: October, November, or December, 1878, in which the fibrous carbon illuminant was made of any other material beside paper?

A. I cannot be certain that I did. There was a good deal of talk there between Mr. Man and Sawyer and I about the carbons made of all sorts of fibrous material, but I don't recollect of seeing lamps in which

carbons made from such fibrous material were 3993
used; I have a very distinct recollection of seeing the paper carbons and of talking about the others.

17 Q. What other materials do you refer to?

A. Broom corn and willow twigs, the fibre of the twigs and a great variety of wood that Man told me about, the names of which I cannot now undertake to repeat, hemp, manilla and cotton thread was especially mentioned, I recollect that. I cannot say now that I saw any of these materials carbonized or used 3994
in the lamps.

18 Q. Can you produce a lamp such as you saw used in 1878, by Sawyer and Man, having a fibrous carbon illuminant, and if so, please do it?

A. Yes. The lamp I now produce, or substantially such a lamp. The two ends of the bow-shaped illuminant are slipped down in the divided ends of the carbon holders of this lamp and were fastened in there by some sort of carbonaceous cement, I don't know what the cement was made of. The bow or arch of 3995
the illuminant projecting above the holders.

> The lamp referred to is offered in evidence and marked "Complainant's Exhibit, Sawyer-Man-Broadnax Lamp, No. 2, Nov. 28, 1888."

19 Q. State what you know of the history of the two lamps now in evidence, "Exhibits Broadnax Sawyer-Man, Nos. 1 and 2"?

A. The two lamps referred to in the question were given to me by Albon Man, I should say from six to 3996
eight months to a year ago, to be used as exhibits in the case of the Consolidated Electric Light Co. vs. the Edison Electric Light Co. and Thomas A. Edison, in the Southern District of New York, a suit founded on the patent in suit here, and I have had them in my possession ever since, and I recognize them as the same lamps or substantially the same lamps that I saw

3997 in the laboratory of the Electro Dynamic Light Co., in the fall of 1878, as I have testified.

> The portion of the treating apparatus referred to by the witness in answer to Q. 12 is now offered in evidence as "Complainant's Exhibit Sawyer-Man treating apparatus, Nov. 28, 1888."

3998 20 Q. State whether you were at any time requested by Sawyer and Man, or either of them, to apply for a patent on the fibrous carbon illuminant, and if so, give all that occurred in regard to the same?

A. Two or three days previous to October 14, 1878, Sawyer and Man came to my office and brought the inventions mentioned in the assignment, dated Oct. 14, 1878, to me to patent for the Electric Dynamic Light Co., as inventions of theirs, and Mr. Man more especially requested in the presence of Mr. Sawyer, and to
3999 which Mr. Sawyer assented, that those inventions should at once be conveyed to the Electro Dynamic Light Co., and that I should then proceed to patent them, and I accordingly did proceed, and drew the assignment, and at once prepared an application for a patent for two of the inventions mentioned in that assignment, viz.: the "Improvement in Electric Lighting Apparatus and Circuits," and also for the improvements in the "Treatment of Carbons to be used for Electric Lighting." The preparation of the applica-
4000 tion for the carbon themselves was temporarily deferred until I could have time to consider the best form to put the application in. I mean, of course, the invention of the bow or U-shaped carbon made of paper or other fibrous material. The application for the lighting circuits and apparatus, and for the process for treating carbons was filed as soon as I could prepare them, which was within a week probably. The preparation of the application for what we now call

the fibrous carbon conductor, making the subject mat- 4001
ter of the patent in suit, was deferred at first because I was in doubt as to the patentability of some of the features that Sawyer and Man wanted to claim. The feature about which I was in doubt, and about which they were very tenacious, was the making the incandescent conductor of paper or other fibrous material. I had no doubt about the patentability of the loop form of the carbon conductor in combination with the lighting circuit in the lamp, believing as I did, and as they did at that time, that such a form of conductor was new, 4002
irrespective of the carbon of which it was made; but whether the incandescent conductor made of fibrous or textile material irrespective of its form or combination was a patentable invention, was a question about which I had my doubts, and I took a good deal of time to think about it and to make up my mind as to the best form to put it in, and whether if such a patent could be obtained, it could be sustained. Upon this subject I had a good many interviews with Sawyer and Man, and we discussed the subject in its various as- 4003
pects under all the light that we had at that time upon the matter. Mr. Man and Mr. Sawyer and myself, respectively, drew a good many different forms of claims to cover that invention. Finally, I drew a complete specification of the invention in lead pencil on buff drafting paper at my house in Baltic street, Brooklyn, Mr. Man having become very solicitous and urgent in having me prepare such an application. After the specification was prepared I took it over to Mr. Man's office, No. 3 Mercer street, going directly from my 4004
house to his office. Mr. Man took the draft of the specification in his hand and glanced over it, but was so much occupied with the business of his office that I could not get his attention. He told me to take the paper to Sawyer and go over it with him. I took the paper, going directly from Man's office to Sawyer's office, which was then in Walker street, and tried to get Saw-

4005 yer to read it over with me, but he was busy writing a
paper of some sort and would not take the time to go
through the specification and discuss it with me, but
said he would take the paper and read it and amend it,
if necessary, so as to convey his thoughts, and return
it to me. I explained to him that the paper contain-
ed probably more than it ought to contain in some as-
pects of it, and in some it probably did not contain
enough, and I specially requested him to write in and
4006 strike out what he thought would be proper, he being
then, or was thought to be, a very good electrician,
and I having very little knowledge of the subject. I
left the paper with him, and I have never seen it since.
This took place, as I think, in April, 1879. At all
events, it was just before Sawyer went to Ansonia to
superintend the making of the Sawyer and Man lamps
at the works of Wallace and Sons. During that same
summer I went to Ansonia on a visit to the works of
Wallace and Sons, along with Thomas Sault, an engi-
4007 neer of New Haven, and while there I met Mr. Sawyer
and asked him if he had revised the specification that
I had given him. He said he had not, but that he had
read it over, and would give it his attention as soon as
he could get time. I do not recollect of ever having
spoken to him about the paper afterwards, nor do I
remember his mentioning the paper to me afterwards.
In fact, I did not see Mr. Sawyer again until quite late
in the fall, either in November or December, 1879,
when he was engaged in an effort to organize the East-
4008 ern Electric Manufacturing Company, and had become
bitterly hostile to the interests of the Electro Dynamic
Light Co. I went to see him either in November or
December at his house, I think, which was in 54th
street, New York, where he was engaged in making an
exhibition of the Sawyer-Man lamps, as a part of his
scheme in organizing the Eastern Electric Manufactur-
ing Co. I went there, I think, with Albon Man to get

him to execute some papers, which he refused to do. 4009
What the papers were that I took to him for his exe-
cution I do not now remember, but they were some
papers in the interest of the Electro Dynamic Co.,
which he very postively and peremptorily refused to
execute. After that I don't think I saw Mr. Sawyer or
had any intercourse with him till after the organization
of the Eastern Electric Manufacturing Co., and the as-
signment of the patents of the Electro Dynamic Light
Co., known as the Sawyer-Man patents, to the Eastern 4010
Electric Manufacturing Company.

Adjourned till Tuesday, the 4th day of December
next, at 11 A. M.

TUESDAY, December 4th, 1888, 11 A. M.

4011 Met pursuant to adjournment, and adjourned till $2\frac{1}{2}$
P. M.

$2\frac{1}{2}$ P. M.

Met, present counsel as before, and the examination
of Mr. Broadnax proceeded as follows:

21 Q. You have referred to an assignment dated
October 14, 1878, which is in evidence as "Complain- 4012
ant's Exhibit Sawyer-Man assignment of October 14,
1878," please state whether any of the inventions re-
ferred to in that assignment were patented, and if so,
give the number and dates of such patents?

A. Yes, there were. Two of them were patented
immediately. The first patent is entitled "Improve-
ment in Switches for Electric Light," and is numbered

4013 210,152, and is dated November 19, 1878. The application for that patent was filed October 15, 1878, and in the first paragraph of the specification the invention is described as "certain new and useful improvements in Electric Lighting apparatus and circuits," the same as in the assignment referred to. The second invention is entitled in the assignment as "Carbon for Electric Lights." For that invention the application was not filed until January 9, 1880, and the patent is dated and numbered as follows: May 12, 1885, No. 317,676,
4014 the same being the patent in suit. The third invention which was conveyed by that assignment was for a novel process of treating carbons for Electric Light. The application for that patent was filed October 15, 1878. The patent is dated January 6, 1879, and is numbered 211,262. These three inventions were all conveyed by Sawyer and Man to the Electro Dynamic Light Company by the assignment mentioned in the question.

22 Q. There is an assignment in evidence called "Complainant's Exhibit Sawyer-Man assignment of
4015 January 9, 1880;" can you state the purpose of that assignment, in view of the fact that the invention therein conveyed is in accordance with your last answer, one of those conveyed by the assignment of October 14, 1878?

A. I did not draw the assignment referred to in the question, but I was present when the assignment was executed by Albon Man, and I understood from him at that time, that the object of that assignment was to authorize the Commissioner of Patents to issue the
4016 said patent to the Electro Dynamic Light Company as the assignee of Sawyer and Man, which the assignment of October 14, 1878, omitted to do.

23 Q. What was the attitude of Sawyer to Man and to the Electro Dynamic Light Company during the period from November, 1878, until December, 1879?

A. As I understood it, from my intercourse with them, the relation between Sawyer and Man was quite

friendly in November, 1878. In December of the same 4017
year, the relations between Sawyer and Man as individuals, and between Sawyer and the Electro Dynamic Light Company became somewhat strained, on account of the intemperate habits of Mr. Sawyer. In January of 1879, about the same strained condition continued, but perhaps growing a little more pronounced, and it continued in that way until March, 1879, when the Electro Dynamic Light Company and Mr. Man who was President of that Company, determined to close 4018
their shop or laboratory of which Mr. Sawyer was the superintendent. Mr. Sawyer then, or about that time, as I understood it, demanded of the Electro Dynamic Light Company a license or right to work under all their patents, which the Company, as I understood it, refused to give him; but shortly after that, or about that time, as I now remember, an arrangement was made with Wallace & Sons to manufacture the Sawyer-Man lamp, under the supervision of Mr. Sawyer at the workshop of Wallace & Sons at 4019
Ansonia, Conn. Mr. Sawyer, in performance of this arrangement, went to Ansonia and had under his supervision a lot of lamps manufactured. I saw Mr. Sawyer at the works of Wallace & Sons in the summer of 1879, I think it was June or July. I talked with him about the lamps in a general way, and about the Electro-Dynamic Light Company. Sawyer during that interview, while he did not say anything that was pronounced against Mr. Man or the Electro-Dynamic Light Company, seemed to me from his conversation 4020
to be restless and dissatisfied with his position there. From that time on, until some time in November or December, 1879, I don't recollect of seeing Mr. Sawyer, but at the time last mentioned, I in company with Mr. Albon Man visited his house, which I think was in West 54th street, west of Sixth avenue. I went up there with Mr. Man and took some papers with me, in the interest of the Electro-Dynamic Light Company

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for Mr. Sawyer to execute. What those papers were, I cannot now be certain, but my impression is, that it was an application for the reissue of the Sawyer-Man Patent No. 205,303, dated January 25, 1878. I recollect that I had been instructed by the Electro-Dynamic Light Company to prepare an application for the reissue of that patent and I think it was that application that Mr. Man and I went to get Mr. Sawyer to execute at the time mentioned. Mr. Man solicited in my presence Mr. Sawyer and urged him in a friendly way to
4022 execute the paper, which Sawyer refused to do. I afterwards, on the same occasion, when Mr. Man was not present, urged upon Mr. Sawyer the importance of executing the paper. Mr. Sawyer replied he had considered all that, and said he would be "damned if he would execute any papers in the interest of the Electro-Dynamic Light Company." I don't recollect of having any further intercourse with Mr. Sawyer until the time the negotiations were pending about the transfer of the patents of the Electro-Dynamic Light
4023 Company to the Eastern Electric Manufacturing Company, which was in the early part of April, 1881.

24 Q. Did you during the period between the time you prepared the specification which you gave to Sawyer, in December, 1879, make any effort of any kind to get the application for the patent in suit executed?

A. I have already stated that I never saw the draft of the specification for a patent of the invention covered by the patent in suit, after I gave it to Sawyer, just before he went to Ansonia, but at the time I saw Mr.
4024 Sawyer at the works of Wallace & Sons, in Ansonia, I asked him why he did not revise the specification I had given him and send it to me that I might perfect the application for the patent; to which he replied, that he had been very busy in getting the work at Ansonia started, meaning the manufacture of the lamps, and had had no time to do anything else, but he said he

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would look the paper up and go through it and send it to me. From that time I did not see Mr. Sawyer again till November or December, as I have mentioned, and I do not remember to ever have spoken to him about that paper; I have an impression that about the time that I visited Mr. Sawyer with Mr. Man in November or December, 1879, at 54th street, that Mr. Man asked me about the application for a patent of the invention of the patent in suit, referring to the draft of the specification I had given to Mr. Sawyer, at which time I 4026
think I told him of my interview with Mr. Sawyer at Ansonia. After that I don't recollect of my saying anything further to Man on the subject, or he to me, until the Sunday morning succeeding the publication in the New York Herald of an article describing Mr. Edison's invention of his electric lamp, and the use of the fibrous or paper carbon. I found Mr. Man in his office, very much engaged with people upon the business of his office, and did not get an interview with him of more than a few minutes. I called his 4027
attention to the article in the Herald, and urged upon him the importance of the getting in the Patent Office an application for the invention in question at the earliest possible moment. He replied that he was busy in carrying on some negotiations which he hoped would result in an application for the patent in question. That, I think, is the last interview I had with Mr. Man upon the subject, until the day the application for the patent in suit was executed at the office of 4028
Charles A. Cheever.

25 Q. What description, if any, did Sawyer and Man give you of their improved lamp, having the fibrous carbon illuminant, at the time they first spoke to you about it, including the time when you first saw the lamp in operation?

A. The lamp they described to me, and a sample of which they brought to my office, was, as I now

4029 recollect it, exactly like the lamp "Complainant's Exhibit Sawyer-Man Broadnax Lamp No. 2," but in the lamp that they showed me there was set in the top of the two electrodes an arch-shaped carbon, one end of the arch of said carbon being set in one of the carbon electrodes that appears in this lamp, and the other end of said arch in the other of said electrodes. Whether this lamp was brought to me on the day that the assignment of Oct. 14th, 1878, was made, or whether it was
4030 brought to me a few days after that, I cannot now remember; but I am clear that it was either at the time, or within a few days after that, that a lamp like this was brought to me, and I think with it was brought the lamp that is illustrated and described in their patent 210,809, and the distinction between that lamp and this was pointed out to me, as was also the advantage of this lamp over that, in that the connection between the electrodes and the two ends of the illuminant was a fixed close union of the two parts of the circuit, by
4031 which the possibility of the formation of the electric arc at the junction between the illuminant and the electrodes was avoided. The method of sealing the lamp, and of exhausting and filing the chamber of the lamp was also explained to me, as was also the method of making contact between the lamp and the lighting circuit in which it was to be set. I do dot see that I can describe any better or more accurately the method of making, sealing, exhausting, and filling of the lamp of the Patent 210,809 than it is described in that pat-
4032 ent; and this lamp, I mean the "Exhibit Sawyer-Man Broadnax Lamp No. 2," last referred to, was made, exhausted and charged precisely as was the lamp of Patent 210,809; differing from that, however, in its interior construction, by leaving out of the chamber of the lamp all of its machinery excepting the leading-in conductors and the soap-stone disc fixed to the top of said conductors. In place of the machinery above the

soap-stone in Patent 210,809, the inventors used in this lamp two straight studs, in the top of which the arch formed carbon made of paper was set and cemented with some sought of carbonaceous cement. The bottom end of the globe of the lamp was ground upon a glass disc and was fastened and sealed substantially as shown and described in Patent 210,809 and in the patent in suit. The inventors, at the time explained to me that they had used in the chambers of their lamps a vacuum in place of the gas or gases described in the Patent 210,809. This was in response to a question of mine, why they did not use a vacuum in the chamber of their lamp instead of the gases; to which they explained that they had used a vacuum, and that it answered first-rate when they could get a good vacuum, but they had no pump with which they could get a vacuum that was at all effectual, as a rule, in the construction of their lamps, and that they had, therefore, adopted an atmosphere of pure nitrogen for the interior of their lamp, which atmosphere they could make more or less attenuated as practice might seem to require, to ensure a satisfactory lamp. 4033 4034 4035

Adjourned till Wednesday, the 5th inst., at 11 A. M.

WEDNESDAY, December 5, 1888.

Met pursuant to adjournment.

Present—Counsel as before, and the examination of Mr. Broadnax continued as follows: 4036

26 Q. State whether or not in your intercourse with Sawyer and Man, or either of them, you observed any want of appreciation on their part of the value and importance of the invention of the patent in suit?

A. No, I did not: on the contrary, they expressed a

4037 very high estimate of its value, and Mr. Man was especially enthusiastic over it, and was very persistent in claiming a patent for it in the broadest language, both in the presence of Mr. Sawyer and in his individual interviews with me, and urged upon me the importance of getting the specification in good shape, and getting the application for the patent filed.

27 Q What, if anything, did you know of Sawyer's habits of sobriety, and their effects on his conduct dur-
4038 ing this period?

A. Mr. Sawyer was intemperate in his habits when I first made his acquaintance, and his habits in this particular grew worse up to the time he died. At intervals he would be sober, reasonable and manageable, and then again at intervals he would be half or wholly intoxicated, capricious and utterly unmanageable, and do and say all sorts of foolish and extravagant things. It was that, as I understood it, that led to the disruption between him and Man, and to the closing of the
4039 work shop or laboratory of the Electro-Dynamic Light Company, and to his dismissal from the works of Wallace & Sons at Ansonia. As solicitor for the Electro Dynamic Light Company, I was frequently brought in contact with Mr. Sawyer and know of my own knowledge how very capricious he was. One day he would talk a thing up, and the next day he would talk the same thing down. From what I know of my own knowledge, and from what I heard of Sawyer from others, in a general way, I made up my mind, and fre-
4040 quently told my clients, that notwithstanding Sawyer's great reputation as an electrician, it was utterly impossible to carry on any business enterprise with him at the head of it, or in any controlling position.

Adjourned till Thursday, to-morrow, 6th inst., at 11 A. M.

THURSDAY, Dec. 6, 1888. 4041

Adjourned till Monday the 10th inst., at 11 A. M.

MONDAY, Dec. 10, 1888.

Attended and adjourned subject to new notice.

TUESDAY, Dec. 18, 1888. 4042

Met pursurnt to annexed notice.

Present—Thomas B. Kerr, Esq., on behalf of complainant, and Richard N. Dyer, Esq., on behalf of defendant, and the taking of testimony herein was adjourned till January 7, 1889, at 11 o'clock A. M.

MONDAY, Jan. 7, 1889. 4043

Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Broadnax, by Mr. Dyer, proceeded as follows;

The following objections to questions and answers are made by counsel for defendant, with the consent of counsel for complainant, that the said objections shall have the same 4044
force and effect as if made on the conclusion of said questions and answers, respectively.

6 A. What was told the witness by Sawyer and Man, objected to as hearsay.

8 Q. Objected to as assuming that the wit-

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ness has testified that he saw lamps having carbons of paper or fibrous material.

13 A. What the witness says as to the material that was put into the retorts, and what the carbons that came from the retorts were made from, and how the retorts were packed, and how or where the carbonizing was done, and whether there was any carbonizing done by means of the retorts, objected to as hearsay.

4046 16 A. Talks between Man and Sawyer objected to as hearsay.

17 Q. Objected to as calling for hearsay.

17 A. Objected to as hearsay.

25 Q. Objected to as containing hearsay testimony so mixed up with pretended statements of facts as to leave it uncertain as to which are facts and which hearsay.

Cross-examination *de bene esse*, without waiving objections.

4047 28 x-Q. Did you not on the 17th day of March, 1881, testify as a witness for Sawyer and Man in an interference case with Thomas A. Edison, involving the application of Sawyer and Man, upon which the patent in suit was subsequently issued?

A. I testified as a witness in an interference between Sawyer and Man and Thomas A. Edison, in which was involved the application for the patent in suit. On what day, I don't recollect, but the record will show on what day the testimony was given, and what the testi-
4048 mony was.

29 x-Q. Was not the application of Sawyer and Man involved in that interference, the application on which the patent in suit was subsequently issued?

A. Yes.

30 x-Q. Have you not records or memoranda in your office by which you can refresh your recollection as to the date when you gave that testimony?

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A. I have what purports to be a printed copy of the record in that interference; I have no other memorandum in writing by which I could determine that date. It appears by that record that my deposition in that case was given on the 17th of March, 1881.

31 x-Q. You were acting as the attorney for Sawyer and Man in taking the testimony in the interference case, were you not?

A. I was.

32 x-Q. And you then produced yourself as a wit- 4050
ness on behalf of Sawyer and Man to establish, so far as you knew, the facts of their claim to priority of invention upon the use of carbonized paper as the conductor for an incandescent lamp?

> Objected to as incompetent, as not cross-examination, and as not the best evidence, the production of the interference record being the proper evidence of the issue involved in said interference and the nature and object of 4051
> the witness' testimony in such case, as the same may appear by the production of his deposition referred to.

A. On the earnest solicitation of my client, Mr. Man, I gave the deposition referred to for the purpose of establishing the fact that Sawyer and Man made and used an incandescent conductor for an electric lamp in the Fall of 1878.

33 x-Q. Was that the only object of your deposition 4052
in the interference?

A. The only object that I remember now. Generally, the object of my deposition, and that of the other depositions in the case, was to establish priority of invention in Sawyer and Man upon the issue involved in the interference.

34 x-Q. How would your testimony "that Sawyer and Man made and used an incandescent conductor for

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an electric lamp in the Fall of 1878" help the case? Was the issue as broad as that?

> Objected to as incompetent, as not calling for the best evidence in regard to what the issue of the interference was.

A. I have not got the record before me, and cannot, therefore, swear what the issue was. I can only give you my best recollection of it. As I recollect it, the claim
4054 that was made the subject matter of the issue was an incandescent conductor for an electric lamp formed of carbonized paper. How far my testimony went to support priority in invention in Sawyer and Man on that issue will appear by the record.

35 x-Q. Your object in giving the deposition, however, was to assist in the establishment of priority of invention on behalf of Sawyer and Man by means of such facts as were within your own recollection?

4055 All after "Man" objected to as an assumption, and forming no part of the question.

A. I take it for granted that that was my object, for I can see no other object that I could have had in making that deposition.

36 x-Q. In that interference case you testified as follows, did you not?

> "Immediately after November 5, 1878, I was at the shop of Sawyer and Man, on the
> 4056 corner of Walker and Elm Streets, in this city, in consultation with them about certain applications for patents which I was then preparing for them; that while there I saw illuminated an electric lamp substantially like that illustrated by the drawing "Sawyer Exhibit No. 4." The lamp was fitted with a section of carbon in the lighting circuit, that being the illuminating part of the lamp. The

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> section of carbon was U or arch shape, resembling the letter U inverted. The carbon was held between the divided ends of the metallic part of the circuit in the lamp by clamps like that shown in the drawing. Mr. Sawyer told me that the section of carbon in the lamp, being the illuminating part of it, was made of paper, and expressed the determination to get a patent for it. Whether the carbon was made of paper or not, I do not 4058
> know. I did not see it made, nor did I have the carbon in my hand. The lamp was sealed up and in place and illuminated. I was probably in the shop half an hour—certainly not more than that talking with Mr. Sawyer about his lamps and his carbon, while I was there Mr. Sawyer arranged the light so as to throw a shadow of it on a screen to show me that that form of burner cast no shadow. Mr. Broadnax adds that he was solicitor for the 4059
> Electro-Dynamic Light Company at that time, and was consulting Mr. Sawyer upon the subject of patents for which he was then applying, and fixes the date which he has mentioned of the time he called there by the date of the application for the patent 210,809, which application was prepared and filed by me."

Objected to as incompetent, irrelevant and not the best evidence. 4060

A. I do not know whether I did or not. I swore to something to that effect, speaking in a general way. I cannot swear at this time what I stated then.

37 x-Q. Have you any doubt of it?

Same objection

4061 A. I have no doubt that what I signed and swore to at the time was the truth, but what that was I do not know now, excepting as it appears in the record which I have not got. I will be very glad to verify my statement in the record if you will present it.

38 x-Q. As a matter of fact, you examined your deposition in the interference case just before or at the time of giving your direct-examination in this case?

A. No, I did not.

4062 39 x-Q. When did you examine it last?

A. I cannot tell you exactly the date, but it was some time after my examination in chief here in this case.

40 x-Q. Then your direct examination in this case was given without refreshing your recollection by referring to what you testified to on the same subject matter nearly eight years ago in the interference case?

Objected to because it don't appear that the
4063 alleged testimony of the witness was about the same subject matter.

A. Yes. The facts about which I testified upon my examination-in-chief here have been kept so fresh in my mind since they occurred that I had no difficulty in stating them without refreshing my memory by reading up the deposition referred to. I did not even think of it until my examination-in-chief was concluded.

4064 41 x-Q. Have you not in your possession memoranda by which you can refresh your recollection as to what you did testify in the interference case?

Objected to as incompetent.

A. I have only what purports to be a printed copy of the interference record in my possession.

42 x-Q. Have you not a certified copy of that record? 4065

A. No, not now.

43 x-Q. Where is the one you did have?

A. In the possession of the printer.

44 x-Q. Have you not in your possession copies of the printed record which you retained as attorney for Sawyer and Man in the interference case?

Objected to as incompetent. 4066

Adjourned for lunch.

Resumed after lunch.

A. I have not, although since our adjournment I have looked through my papers in that case. My recollection is that the last copy I had of that interference case I sent to the Patent Office to be certified as a part of the interference record.

45 x-Q. Are you not the solicitor for the complainant in a suit pending in the Southern District of New York on the same patent against the Edison Electric Light Co. and Thomas A. Edison, commenced in 1885, after the issue of the patent in suit No. 35,531 in equity? 4067

A. I am.

46 x-Q. And is it not a fact that in that case, as solicitor for the complainant, you have taken hundreds of pages of testimony in order to carry back the date of the invention by Sawyer and Man to a date anterior to the filing of the application? 4068

Objected to as incompetent.

A. It is a fact that I have taken hundreds of pages of testimony in that case to prove, among other things, that Sawyer and Man made the invention, the subject

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of the patent in suit, long before the application for the patent was filed. Perhaps it would be nearer accurate to say that hundreds of pages of testimony have been taken, most of which is cross-examination, about matters not pertinent to the issue.

47 x-Q. And in that case you put in evidence, did you not, a duly authenticated copy of the record in the interference case, including the record in your deposition given in March, 1881?

A. I did put in what purports to be a certified copy
4070 of that record, and I presume it contains or includes a copy of the deposition referred to in the question?

48 x-Q. Has the record of that case yet been filed in the Clerk's office?

A. No, the record is not completed.

49 x-Q. It is in fact still in your possession as counsel for complainant?

A. Yes, it may be said to be so.

50 x-Q. Will you, then, kindly refresh your recol-
4071 lection from that record which you yourself have offered in another case as a correct copy of the record, and give me an answer to cross-question 36?

A. I have not got the record in my office; as I explained this morning, it is at the printer's, but I suppose I can get it up here in the morning.

51 x-Q. Will you kindly do so?

A. I will.

52 x-Q. How long after the fore part of October, 1878, did you remain under retainer as solicitor for the Electro Dynamic Light Co.?

4072 A. I was solicitor for the Electro-Dynamic Light Co., if my memory serves me right, down to the time that the patents of the Electro-Dynamic Light Co. were transferred to the Eastern Electric Manufacturing Co., and indeed after that, and although I went into the service of the Eastern Electric Manufacturing Co., I

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still continued to be counsel for the Electro-Dynamic Light Co., at least in matters appertaining to their patents.

53 x-Q. What were the relations of Sawyer and Man with the Electro-Dynamic Light Co., and the Eastern Electric Manufacturing Co. with regard to their joint inventions in electric lighting?

A. Sawyer and Man assigned all their inventions and patents to the Electro-Dynamic Light Co. and they both of them became officers in that company.
After the patents were assigned to the Eastern Electric 4074
Manufacturing Co. Mr. Sawyer became a stockholder in that company. Whether he was an officer in the company or not, I don't know. Mr. Man also became a stockholder in that company. Whether he became an officer in it, I don't know.

54 x-Q. The assignment to the Eastern Electric Manufacturing Co. is dated April 6, 1881, is it not?

A. It appears by the assignment itself.

55 x-Q. And at the date of the application for the 4075
patent in suit, viz., January 9, 1880, the Electro Dynamic Light Co. was the owner of the inventions of Sawyer and Man relating to electro lighting, and you were retained solicitor of that company for the purpose of applying for patents for inventions owned by that company?

A. I was the solicitor of that company to do anything required of me that I might properly do, and I did apply for patents for all the inventions that were brought to me to be patented, or at least I prepared 4076
the papers for the applications. In some instances, however, the applications were not perfected and filed by me. I think it is proper for me to say that I did not prepare and file the application for the patent in suit, although the Electro-Dynamic Light Co. evidently regarded me as its solicitor at that time, because at the

4077 time the application was executed, I was called upon by Man, who, I think, was the Vice-President and Acting President of the Company at that time, to go with him to the office of Mr. Cheever and consult with him about the application, and I did go, and was present; but I took no part in the preparation of the application, although Mr. Man consulted me about the specification, or asked me what I thought of it, or something to that effect. I told him I thought the specification
4078 was rather crude, to which Mr. Baldwin replied, who was the solicitor of Mr. Cheever, that he had written the specification in great haste, and that it was his intention to immediately file an amended specification. After that I had nothing to do with the case until after the interference was declared.

56 x-Q. What was the first application you prepared for Sawyer and Man as solicitor for the Electro-Dynamic Light Co?

A. I really do not recollect. There were a lot of in-
4079 ventions brought to me by Mr. Sawyer and Man in the fore part of October, 1878, to be patented, but which application was prepared first I could not tell you.

57 x-Q. As a matter of fact, did you not, after your employment in 1878, prepare and prosecute all the applications made by Sawyer and Man for electric lighting, except the application for the patent in suit?

A. As a matter of fact I do not know. Sawyer and Man may have sent some applications to other solic-
4080 itors about which I have no knowledge, but I did prepare several applications for patents for them right along, from the time I was first employed down to the time that Sawyer and Man, or Sawyer and the Electro-Dynamic Light Co. got at loggerheads, and among the rest was a draft of a specification for the patent in suit mentioned by me in my examination in chief.

58 x-Q. Judging from the patents issued to Sawyer and Man, with which I assume you are entirely familiar, do you know of any such application except the patent in suit, which was not prepared and prosecuted by yourself? 4081

A. I cannot say that I do so as to be able to distinguish them, but there were some applications prepared by Sawyer himself, but the numbers of those applications, or the inventions described by them I cannot tell at this time, for the reason that I do not remem- 4082
ber, but I know there were such applications filed by Sawyer, because after they were filed a power of attorney was given to me to prosecute them, and there were quite a number of them.

59 x-Q. So far as you know, were there any applications for patents filed on behalf of Sawyer and Man relating to electric light between the time of your employment in October, 1878, by the Electro-Dynamic Light Co. and April, 1881, when the assignment was made to the Eastern Electric Manufacturing Co., ex- 4083
cept the application for the patent in suit, in which any other solicitor except yourself was employed, either to prepare or prosecute the applications?

A. I don't know of any application made by Sawyer and Man for joint inventions in which I was not employed as solicitor between the dates mentioned by you, excepting the application for the patent in suit. The application that was *filed* in that case I did not prepare and was connected with it only as I have stated. 4084

Adjourned till Tuesday the 8th inst. at 11 A. M.

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TUESDAY, January 8, 1889.

Met pursuant to adjournment. Present, Counsel as before, and the cross-examination of Mr. Broadnax continued as follows:

60 x-Q. Have you obtained from the printer the authenticated copy of the interference record which you offered in evidence as counsel for complainant in case 3,553, in the Southern District of New York?

4086 A. I have.

61 x-Q. Will you refresh your recollection and tell me whether or not you testified in that case as stated in cross-question 36?

> Objected to as incompetent, and as an effort to bring into the case a garbled portion of a record in another case, and as inadmissible in the absence of the production of the entire record in such case. Counsel for defendent is
> 4087 notified that in following this line of examination he makes the witness his own, and that a motion will be made to expunge all such examination from the record at or before the hearing of this cause.

A I have read the deposition as it is printed in the certified copy referred to in the question, but whether that statement is a true statement of what I said in giving my testimony at that time in that case I do not

4088 know, as I have already stated, I recollect testifying in that case, and whatever I said was undoubtedly true, but whether that is a correct statement of what I said, I don't remember.

62 x-Q. Have you any doubt as to the correctness of this copy which you yourself offered in evidence in another case as a correct copy?

Same objection.

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A. I put it in evidence in the case referred to, assuming the statement of what I said to be correct, but I can't swear now that it is.

63 x-Q. The matter quoted by me in cross-question 36 is your entire direct examination in the interference case, is it not?

Same objection.

A. Yes, if the statement quoted is a correct statement of what I said. 4090

64 x-Q. And the direct examination quoted contains the only statements in the deposition with regard to your knowledge and information as to the making and using of paper carbons by Sawyer and Man?

Same objection.

A. What is contained in that statement in my deposition appears in that statement itself. Whether the statement contains all I said or not I don't know. The 4091 statement does not contain all the knowledge and information I had at that time about the making and using of paper carbons by Sawyer and Man. The object of the deposition, as I remember it, was to fix the date of their use of paper carbons. I very reluctantly made any deposition in the case at all, but the object was merely to corroborate the other witnesses as to the date, and I purposely omitted saying anything more than was just necessary to fix that date.

65 x-Q. If, however, you then knew of your own 4092 knowledge that the carbon in any lamp of Sawyer and Man you had seen was made from paper, you would have said so in the deposition in the interference case, would you not?

Same objection.

A. What I wanted to do, and did do, was to fix a

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date as nearly as I possibly could by reference to some circumstance that I was sure of at which time I had certainly seen their lamp illuminated with a paper carbon illuminant. If there had been any earlier date that I could have fixed with certainty, I think I would have mentioned it without doubt.

66 x-Q. And if you had known of your own knowledge of lamps made and used by Sawyer and Man, you would have said so instead of resting on the statements as you did, that Mr. Sawyer *told* you that the section
4094 of carbon in the lamp was made of paper ?

Same objection.

A. If I had seen the paper carbon put in the lamp that was then sealed up and illuminated, I would undoubtedly have said so, but I did not see the paper carbon put in that lamp, and could not, of course, swear that the illuminant was made of paper, although I had no doubt but that it was.

67 x-Q. And if at the time of so testifying you recol-
4095 lected having seen any other lamp of Sawyer and Man in which you knew of your own knowledge the carbon to be made of paper you would have said so, would you not ?

Same objection.

A. Well, I don't know whether I would or not. I knew that they were making paper carbons and incandescent electric lamps, but I don't now recollect that I ever saw either Sawyer or Man, or either of their work-
4096 men, take one of the carbons that I know to be of paper and put it in the lamp. In that interference I had abundantly proved the fact by other witnesses that they did make paper carbons, and did put them in the lamps, and did illuminate them so that I made my own deposition as brief as possible, intending only to cor-

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roborate the other witnesses as to the date. If I had been examined by another counsel the deposition would probably have been very much fuller, but being counsel, I very reluctantly made any deposition at all. In the deposition that I did make, I said as little as possible, and satisfy Mr. Man, who insisted that I should at least swear to the date.

68 x-Q. At the time of your visit to Mr. Man's office, as stated in answer 2, how many lamps like "Exhibit Sawyer-Man lamp No. 1" did he show you ?

A. Upon my visit to Mr. Man's office on that occa- 4098
sion, I followed him into his private office, and in my presence he opened his safe door, I standing directly in front of the safe, so that I could look right into it, and I saw there a number of lamps, I should say not to exceed three or four. He took one of them out and showed it to me, as I have stated, but he did not take any of the others out.

Adjourned till 1:30 P. M.

Resumed after adjournment. 4099

69 x-Q. After being shown this lamp at Mr. Man's office, was the same lamp taken to the shop No. 2, Howard street ?

A. Yes, I think it was.

70 x-Q. That lamp had a straight illuminant in it, did it not ?

A. It did.

71 x-Q Please explain how it was put in circuit ?

A. They had strung alongside of a partition wall cir- 4100
cuit wires, leading, as I was told, up to the shop of Arnoux & Hochhausen, and the circuit wires of the lamp were connected on that wire and hung wrong side upwards.

73 x-Q. As I understand you, it was supported by the wires on the partition ?

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A. By the main circuit wires to which the lamp was hung.

73 x-Q. How long did you see it remain lighted in that position?

A. Well, I can't tell you; not long. I went there to see it illuminated. Probably it was illuminated there fifteen minutes, perhaps half an hour. It was hung, as I have stated, and we stood there, Sawyer, Man and I, for some little time talking about it, and I expressed a
4102 desire to see the dynamo, which was something I had never seen before, as I recollect of. Man took me upstairs to the shop of Arnoux and Hochhausen and showed me a dynamo, and we lingered around there some minutes. Then we came down stairs; the lamp was still illuminated, and Sawyer took it off the circuit wires and gave it to Man. I took it in my hands and looked at it again, handed it back to him, and he took it with him. We walked together as far as Broadway through Howard street, where we parted, he going to
4103 his office and I to mine. I should say that the lamp was illuminated altogether certainly half an hour.

74 x-Q. How much of a shop did they have at that time, and what was in it?

A. Well, they had only a small shop, what I would call a laboratory, with one room, which, I should say, was about fifteen feet wide by about thirty to thirty-five feet long. I could tell you what was in it. There was a work bench, at which Mr. Sawyer was at work fitting together some lamps, several parts of which
4104 stood around on the work bench. I don't recollect that any one else was in the shop but Mr. Sawyer and his father; of the latter, however, I won't be certain.

75 x-Q. What amount of tools and apparatus did they seem to have at that time?

A. I cannot tell; at this date I can't recollect what they did have. I felt no interest at that time, of course,

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in their machinery, so did not take notice, and so really have no recollection of what machinery they had there.

76 x-Q. Is it your impression that the room was one full of machinery and apparatus, presenting the appearance of a busy workshop, or that it was quite bare of machinery and apparatus?

A. My recollection about it is—what recollection I have on the subject is—that the laboratory was quite bare of machinery, but was in immediate connection 4106
with the machine shop of Arnoux & Hochhausen, which was full of all kinds of machinery, to which they had constant access, as I understood it. There was a door leading up from their room up a short stairway to the factory of Arnoux & Hochhausen, into which Mr. Man took me and showed me around.

77 x-Q. That is, the shop of Arnoux & Hochhausen was on the floor above?

A. That I don't recollect. I only recollect that there was a short stairway leading from the laboratory of 4107
Sawyer and Man into the shop of Arnoux & Hochhausen.

78 x-Q. How many lamps did you see in the Howard street shop at the time of your first visit?

A. The lamps that I saw there were lamps that were either in process of construction or had been taken apart to put new carbons in. I think the only lamp that was there that was in condition to illuminate was the one that Man took there from his office.

79 x-Q. You saw no lamp with an arch shaped conductor at that time? 4108

A. No, I did not see any arch shaped conductor in any lamps there, but Sawyer had some arch shaped conductors in a paper box standing on the work-bench which Man took in his hand and showed me, but what they were made of I don't know.

80 x-Q. At the time of the visit to Mr. Man's office,

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and your visit with him to the shop, did Mr. Man tell you of the commercial character of the enterprise he had on hand?

A. I don't recollect now whether he did or not, we were together probably an hour, and during that time I don't think there was anything talked about except the lamps and incandescent electric lighting. The subject was entirely new to me at that time and the lamps and general idea that he talked about of illuminating houses and cities, and all sorts, excited in me a
4010 good deal of interest, but what was said I don't know, except in a general way.

81 x-Q. Did you understand that they had a perfected and commercial lamp, and that the one you saw like "Exhibit Sawyer-Man lamp No. 1" was that lamp?

A. The understanding with which I left Mr. Man, after talking with him about the lamp and the patent or patents, which they had already obtained for it, was that they had worked out a system of incandescent
4011 electric lighting, which they were going to introduce into public use as soon as they could perfect their arrangements to do so, and Man said, I recollect, when I left him, that they had a lot of improvements on the lamp that they were going to patent immediately after vacation, and that as soon as they got ready the would come down and see me. He said that they would take patents out right then, before he went into the country but that they were about organizing a company, and they wanted the company to pay the expenses of tak-
4012 ing out the patents. I don't recollect seeing Man after that till after the summer vacation.

82 x-Q. Was the lamp which you saw illuminated the commercial form of the lamp that Mr. Man proposed to use, as he told you, or was some other lamp to be used?

A. I don't recollect now that he said anything about

4113

that. He showed me that lamp, and I don't recollect that he said anything to me about whether he intended to use that particular lamp commercially or some other form of lamp that they had a lot of improvements on their lamp which they intended to patent, and that they would come and see me when they got ready I don't recollect of seeing the lamp again until they brought it to me in the forepart of October, 1878, at my office.

83 x-Q. How many times did you visit this shop at 4114
No. 2 Howard street?

A. I cannot say now whether I was there again after this visit, of which I have been testifying, or not, I have a vague recollection, or rather impression, of going there and seeing Mr. Church there with Mr. Sawyer, but I do not feel certain enough about it to swear to it.

84 x-Q. When you next visited the shop of Sawyer and Man, it had been moved, as I understand you to the corner of Walker and Elm streets? 4115

A. Yes, it was then the shop of the Electro-Dynamic Light Co., which had been organized in the meantime.

85 x-Q. How long was that shop occupied?

A. As I recollect it, the Company commenced to work there, with Mr. Sawyer as superintendent, and with Mr. Sawyer and Mr. Man as general head and managers of it, about the first of October, 1878, and the shop was occupied by the Company until some time in March or April, 1879. 4116

86 x-Q. How much of a force did they have there, and what was the size of the shop and quantity of apparatus?

A. I could not tell you. They occupied the whole second floor of the building. What apparatus they had there I can't tell you. The shop was full of men

4117

and machinery. At least, the workshop was two rooms the back room was used as the principal, and what I might call the secret work shop, the door of which was generally kept shut. The door of the outside workshop was also generally kept shut. I know I always had to ring the bell to get into the shop.

87 x-Q. When Sawyer and Man called at your office, as stated in answer 4, did they bring any models or lamps with them?

4118 A. They did.

88 x-Q. What were they?

A. I think they brought two lamps and switches; I think they brought two varieties of switches.

89 x-Q. In your answer to ques. 4, you do not say that they brought the lamps with them, but that you saw the lamps a few days after the visit you refer to. Please make it clear just what the circumstances were, as nearly as you can recollect?

A. They certainly brought the lamps with them,
4119 differing somewhat in the detail of their construction, and also models of switches. It seemed to me that one of these switch models was one, the frame of which was made of soapstone, and the other was a switch laid out on a block of wood. The whole business at that time was so entirely novel to me that in a very few days after that I visited Sawyer at the shop, and talked with him about these inventions, and I explained to him that I was not an electrician, and the whole subject was so entirely new to me that I thought it
4120 would be best for him to write a detailed description of these lamps and switches, and so on, to enable me to fully understand what the inventions really were, and in obedience to my advice, he did write a description of such parts of the machine as I did not understand, and at this visit, which I have referred to, I saw these lamps again at the shop.

4121

90 x-Q. And one of these lamps, as I take it, had an arch-shaped conductor, which you were told was made of carbonized paper?

A. Yes, that is as I recollect it.

91 x-Q. Is that the lamp you refer to in your deposition in the interference case which has been quoted in 36 x-Q?

A. I cannot state now which lamp it was that I referred to then. I saw so many of these lamps, either
at my office or at their shop, that it is impossible for 4122
me to distinguish now which one I saw or referred to at that time. I was so unfamiliar with the subject at that time that I was continually sending to the shop for a lamp, or going there to see one, or something that appertained to the matters that I had in hand pertaining to this business.

92 x-Q. Did they seem to be making in quantity any particular type of lamp, if so, what?

A. They were making these lamps, the whole of
which, in so far as their exterior and general appear- 4123
ance was concerned, were pretty much alike, differing somewhat in size. Some of them were quite small, the illuminating chamber being from an inch to an inch and a quarter in diameter, some of them being blown out in the form of a bulb at the upper end. The interior of the lamps differed somewhat in construction, those having the loop or U shaped caborns had nothing above the diaphragm or disc in the lamp I have produced, excepting the loop or bow-shaped carbon set in
studs or electrodes fixed in the disc and secured by 4124
some kind of carbonaceous cement. They made both types of these lamps; of which they made the most, or which they had adopted, or intended to adopt as the best type, I do not know.

93 x-Q. The straight carbons produced by depositing on a core from a hydro-carbon fluid, and then re-

4125

moving the core, produced, as I understand you, straight, hollow or trough-shaped carbons made of a carbon deposited from the decomposed hydro-carbon fluid, and such carbons were not carbons made of paper or fibrous material ?

A. All the carbons referred to in the question were made by first making a carbon of fibrous or textile material, paper or willow wood, for example. That carbon was then put into the treating apparatus, by which it was coated by a deposited carbon obtained by
4126 the decomposition of a carbonaceous fluid or gas. The stick of carbon so formed would be quite long. It was then cut up in sections of the required length. A longitudinal section of this pencil of carbon reduced to the required length was cut out of the side of the pencil. The fibrous carbon was then dug out of the centre of the pencil, the length of the section cut away, thus forming a trough-shaped illuminant, composed wholly of deposited carbon, leaving only a short section of the fibrous carbon in each end of the pencil forming the
4127 trough. In some instances, however, the fibrous carbon was bored out of the centre of the deposited carbon with a needle drill, forming a straight tubular carbon ; of course, it will be understood that where carbons were made in this way, in the form of a bow or arch, they were ground or filed off longitudinally down to the fibrous carbon, which could then be dug out.

94 x-Q. Then, as I understand you, arch or U shaped carbons, as well as straight carbons, were made
4128 by depositing carbon from a carbonaceous fluid upon a core made of a fibrous carbon, and then removing the core so as to leave an illuminant of the deposited carbon. Do I understand you correctly ?

A. Yes ; most of the carbons, as I understand it, that were to be used in lamps of high luminosity, hav-

4129

ing a comparatively large illuminant, were made in that way.

95 x-Q. Please look at the lamp Complainants " Exhibit Broadnax, Sawyer-Man lamp No. 1," does not the trough remnant of the carbon which is loose in this lamp indicate to you that the illuminant of this lamp when intact was one of the straight deposited carbons which you have described ?

A. Yes.

Adjourned till Wednesday, the 9th inst., at 11 A.M. 4130

Monday, January 9, 1889.

Met pursuant to adjournment. Present counsel as before, and the cross-examination of Mr. Broadnax continued as follows :

96 x-Q. What is the foundation in facts of your own knowledge for the statement contained in answer 6, as 4131
follows :

> " In some cases the original pencils were made of some fibrous material cut to size, carbonized, and then treated as described in the patent to Sawyer and Man, 211,262, the fibrous part of the carbon being afterwards removed, leaving a straight shell either in the form of a tube or in the form of a trough of pure deposit carbon ?"

A. I know of my own knowledge that they made 4132
fibrous carbons, as stated in the answer referred to ; I know that they treated those carbons as stated in the patent referred to ; I do not recollect whether or not I saw the fibrous carbons removed after they had been treated, but I saw the carbons after they had been made and a central core of fibrous carbon taken out.

4133

97 x-Q. Please state the facts upon which you base the statement that you know of your own knowledge that they made fibrous carbons as stated?

A. I saw the fibrous carbons taken out of the retort in which they were carbonized. I saw lots of blanks made of paper, and I think some of them were made of willow, but of that I won't be certain. I could very well tell that the carbons that were taken out of the retort were made of paper, because some of them were only partially carbonized, or not carbonized enough to
4134 destroy the appearance of the fibrous quality of the paper.

98 x-Q. The fibrous carbon cores that you speak of then in the first part of answer 6, you think were carbonized paper?

A. Yes.

99 x-Q. How did you get the cylindrical shape of the core which appears from the trough-shaped straight carbons, such as the loose one in "Exhibit I?"

4135 A. I don't know that they were cylindrical, and I don't know that I noticed particularly whether they were or not.

100 x-Q. You don't know, then, that they made these cylindrical cores of paper?

A. I don't recollect of seeing them make, or noticing that the paper filaments were cylindrical. It would have been a very easy matter to make them cylindrical, but whether they did so or not, I don't know.

4136

The second sentence of the answer objected to as volunteered and irresponsive.

101 x-Q. You don't know, then, as a matter of fact, that they used carbonized paper as the cores for these straight, trough-shaped carbons?

4137

A. I think I have give all the knowledge I have upon the subject by actual observation. I have no further knowledge on the subject, except what I have by hearsay. I frequently saw them treating illuminants, both in the form of straight pencils, and in the form of an arch or loop.

102 x-Q. These, you now assume, had been previously cut to shape and size from some fibrous material, and then carbonized by Sawyer and Man, or under their direction, but you do not *know* this?

A. Well, I have already stated, and I now repeat, 4138
that I saw them have and cut filaments of paper. I saw those filaments, or others just like them, taken out of the retort, which retort had been in the furnace of the boiler, and made hot enough to carbonize the paper filaments to different degrees of perfection. I saw these carbons, or others just like them, treated according to their Patent 211,262. Now, whether these same carbons were scarfed off, and the central core dug out, I don't know beyond what I was told, and acting, as I was, in a confidential relation to those gentlemen, I 4139
have no doubt that the information they gave me was the truth.

103 x-Q. Are you aware of the fact that Sawyer and Man, in making these trough-shaped carbons, or at least some of them, took artists' crayons, purchased on the market, reduced them to proper size, and then covered them with the deposit from the hydro-carbon fluid, and then removed the core?

A. I only know that by statements made to me of the fact by Sawyer and Man. I saw some little crayon pen- 4140
cils there, shown to me by them, but I never saw them make any use of them.

104 x-Q. How did you know of your own knowledge that the pieces of carbon which were receiving the deposit were the artists' crayons, or the fibrous material carbonized by them?

4141

A. I saw them treat the paper carbons, Sawyer took some paper carbons that were not, as he said, sufficiently carbonized. He took those carbons for the purpose of showing me the effect of a current upon them, and put them in the circuit. In his treating apparatus he ran the current through them, and as he expressed it, re-carbonized them with the current, and took them out and showed them to me that I might see the effect of the oil and the current on the
4142 carbon.

105 x-Q. How do you know that these were paper?

A. Well, I know that the carbons he treated, as stated in my last answer, were paper, because they were taken out of the retort in my presence along with a lot of others that had not been sufficiently carbonized to lose the appearance that partially carbonized paper would have.

106 x-Q. How many were there of these pieces that Mr. Sawyer treated in your presence, as stated in an-
4143 swer 104?

A. On the occasion to which I refer, there was but one, and I don't recollect that I ever saw him treat any carbons that I knew to be of paper from any other source than the statement of Sawyer and Man. I frequently saw them treating carbons which, they said, were paper, and I frequently saw them treating carbons which they said were French pencils.

107 x-Q. This particular occasion, then, as I understand you, was the only time that you saw Sawyer or
4144 Man, or anybody acting under their direction, treat a carbon made from paper or other fibrous material, where the facts would warrant you in stating that you believe you knew the carbon to be made of paper of your own knowledge?

A. I think I have given you all the information I have, excepting this, that the paper carbons that I saw

made and treated were really made for my benefit. I 4145
was called upon by them to get a patent for this paper, or fibrous carbon illuminant, and I wanted to see, as their solicitor, how these carbons were made and treated, and I went there accordingly, and was shown how the thing was done, as I have stated. After that I frequently saw them treating the carbons and cutting out blanks, as I have already stated.

108 x-Q. Cannot you give an affirmative answer to
cross 107? 4146

A. My answer to the question referred to would be yes, but that should be taken in connection with the explanation I have made so as to convey a fair idea of the facts and circumstances exactly as they were.

109 x-Q. What was the shape and size of this carbon before it was treated?

A. Well, I did not measure it, and any estimate that I may make of its size and length must be taken
in connection with the fact that it is now some ten 4147
years ago since I saw it. The form was a straight pencil, I should say somewhere about two inches long. It may have been a little more. It may have been a little less. Its cross section, I should say, would be that of a good sized knitting needle.

110 x-Q. This was its appearance as it was taken from the retort, as I understand you?

A. No, that was its appearance as it appeared in my hand after it had been treated.

111 x-Q. What was its appearance in size and shape 4148
as it came from the the retort?

A. Well, its appearance was intensely black, but it did not appear to be so hard and stiff as after it had been treated, and its size, I should think, was practically the same, that is, its cross section.

112 x-Q. Was it round like a knitting needle, as you say it was, after it was treated?

4149 A. I don't recollect that I observed it particularly in that particular, and I don't know whether I observed that it was absolutely cylindrical after it came out of the treating apparatus. What I observed more especially was the difference in the appearance of the carbon after it had been treated, I mean in its color especially. It then had a silvery appearance, such as characterizes silver after it has been worked or polished.

4150 113 x-Q. Why did you not observe its shape in cross section when taken from the retort?

A. Well, I probably had no motive in doing so, and I don't know but that I did, but I don't recollect now.

114 x-Q. Did you examine it very critically when it came from the retort?

A. As I recollect, only to this extent. I was comparing the different pieces of carbon that came out of the retort, and calling Sawyer's attention to the difference which Mr. Sawyer explained as being due to the
4151 different degrees of carbonization, and then he showed me that, as I have explained, that particular piece of carbon would be further carbonized by the current, and showed me how it could be, and how it would be changed, and it was done in the twinkling of an eye.

115 x-Q. Did you examine the carbon with a microscope?

A. No, I only looked at it through my glasses.

116 x-Q. This particular piece of carbon, I take it,
4152 was one of the well carbonized pieces?

A. No, I do not so understand it. It was well carbonized after it had been in the treating apparatus; but Sawyer said that he could take any of these pieces that he took out of the box that had been sufficiently carbonized for him to get a current through, and carbonize them to any degree he chose to with a current.

117 x-Q. The carbon, you have said, when taken from the retort, was intensely black. I assume, from

what you have said, that some other pieces in the retort did not present the same intensely black appearance. Please state what the difference was? 4153

A. That was not the idea I intended to convey. I meant merely to make a comparison between the appearance of the carbon before it went into the treating apparatus and its appearance after it had been treated, but as a matter of fact, some of the paper blanks were only partially carbonized, leaving them a very dark brown color, by which any one could plainly 4154
see that the blanks were made of paper.

118 x-Q. Some of the pieces then were intensely black, and some were dark brown as you saw them in the retort, the particular piece that Sawyer afterwards treated for you was of the former color?

A. Some of them, as I have stated, a few of them were of very dark brown color, a few of them seemed to be thoroughly carbonized so that they could be used as Sawyer said without treatment. Others again, while they were carbonized and thoroughly black, were not 4155
sufficiently carbonized, and it was these last that Sawyer said and showed me could be made thoroughly carbonized by running the current through them, and one of which he did run the current through and more thoroughly carbonize it.

119 x-Q. You, however, base your judgment that all the pieces were carbonized paper on the appearance of the brown pieces?

A. Yes.

120 x-Q. What experience had you had which would 4156
enable you to reach this judgment simply from the appearance of the pieces?

Adjourned till 2 P. M.

Resumed after adjournment.

A. At the time referred to I had no experience

4157 whatever in the carbonization of paper for any industrial purpose that I recollect of. Of course I knew what the appearance of partially carbonized paper was but in so far as any experience in the carbonization of paper for use as illuminants for incandescent electric lamps is concerned; I had none whatever.

121 x-Q. How did you know that some of the carbons in the retort "seemed to be thoroughly carbonized."

A. Well, I only knew by the fact that some of the
4158 carbons were hard, and dense, and stiff, and others were less hard, less dense, and I judged that the hard, dense or stiff carbons were those that were most thoroughly carbonized. I recollect expressing my surprise to Mr. Sawyer that carbon could be made of paper, so hard and dense as some of them were.

122 x-Q. Then, as between those that you thought were thoroughly carbonized, and those that while thoroughly black, were not sufficiently carbonized, you distinguished the degree of carbonization by what
4159 seemed to be difference in hardness, density and stiffness?

A. That is the way I understood it.

123 x-Q. What experience had you had to enable you, at that time, to make such subtle distinctions of your own knowledge?

A. I have already stated to you what experience I had in the carbonization of paper for any industrial use. In drawing the distinctions I have mentioned, I merely exercised such judgment as any educated and
4160 intelligent man would be likely to exercise in such case. Of course I took it for granted that the paper carbon illuminant must be hard and dense to be fit for use in a lamp, and that such density would be due to a proper carbonization of the paper.

124 x-Q. What had been your experience in the carbonization of paper?

A. I don't recollect of ever carbonizing paper for any

purpose, unless it was to make what long years ago we 4161
used to call tinder boxes, where there was a carbonization of paper for the purpose of lighting a fire with a flint and steel.

125 x-Q. The tinder box suggestion is a mere guess on your part as to possibilities?

A. No, I recollect, when I was a boy, we always had a tinder box in the house, and I recollect of filling it very often with burnt paper, and of using it for lighting a fire, but the paper, of course, carbonized in that way, was very soft and light. 4162

126 x-Q. With regard to this piece of carbon that Mr. Sawyer treated for you by passing a current through it while immersed in a hydro-carbon fluid, what was done with it after the treatment?

A. I don't know what they did with that particular carbon. I did not remain to see. When they got through with the experiment or operation that I came to see I came away.

127 x-Q. This occurred at the shop on the corner of
Walker and Elm streets, I take it? 4163

A. Yes, and I think it was during the dinner hour, in the middle of the day, that it was done.

128 x-Q. Who else was present?

A. Old Mr. Sawyer was there; whether he remained during the whole operation of treating, I don't recollect.

129 x-Q. Your recollection is, though, that it was the dinner hour, when the men had left the shop and the machinery had stopped?

A. I think so. 4164

130 x-Q. How did they get the current to treat the carbon?

A. I don't know; probably the engine was kept going, or they may have started up after the dinner hour was over before the treatment took place. They had

4165 a little engine and boiler of their own which they could start or stop whenever they chose, but whether they did so or not, I don't recollect. That was a thing that I did not particularly notice. I was there for a specific purpose, and when that purpose was satisfied, I did not take notice of anything else.

131 x-Q. Can you fix the day when this occurred by any papers or patents, or applications for patents?

A. No, I cannot; it was certainly somewhere be-
4166 tween the middle of October and middle of November, 1878. After the visit I testified about, to see the carbons made and treated, I went up there again to see the carbons illuminated in the lamp, and to have a further talk with Sawyer about the switch patents, or lamp patents, on the application for which I was then engaged, either for the European patent or the American patent, I don't recollect which, and probably a further discussion of the manner in which, or of the best method of filing an application for a patent for these
4167 paper carbons, about which there was a good deal of discussion between Sawyer and Man and myself.

132 x-Q. Now please state precisely what took place on the occasion of your visit to the shop before the carbon was treated?

A. I have already stated, upon my examination in chief, and repeated, I think, in different language, on my cross-examination, substantially all that took place. I went up there to the shop as the solicitor for the Electro Dynamic Light Co., to see these carbons made
4168 and treated by preconcerted arrangement, either with Mr. Man or Mr. Sawyer. When I got there to the shop first, Sawyer and I got into a desultory conversation about all sorts of things appertaining to patents and electric light. After I had been there a few minutes, I don't know how long, old Mr. Sawyer, I mean Mr. Wm. E. Sawyer's father called to me, and said: "Mr.

Broadnax, if you want to see these carbons (or something to that effect), come in here." He was in the 4169
workshop. Mr. Wm. E. Sawyer and I both went in there. Mr. Sawyer had the retort opened and took a piece of wire and took the carbons out of the retort, and showed them to me. as I have already stated. We looked at them, and talked about them, and the carbon was treated as I have stated, and when he got through with the treatment of the carbon I went back to my office. It does not seem to me now that I was 4170
there more than an hour, although I may have been. I was there long enough, however, to satisfy myself that the making of an incandescent conductor of carbonized paper was an accomplished fact.

133 x-Q. You did not see the materials before they were put into the retort?

A. No.

134 x-Q. You did not see the retort subjected to heat?

A. No; I don't think I saw the retort in the fire. 4171

135 x-Q. Had the retort been opened when Mr. Sawyer, the father, called to you and Wm. E. Sawyer, the son, to come in and look at the carbon?

A. Yes.

136 x-Q. Then when you first saw the retort on this occasion, it was open?

A. Yes; and it was hot.

137 x-Q. Is this the same occasion as testified to by you in direct answer 13?

A. It is.

138 x-Q. Then you do not want it understood that 4172
the statement is made of your own knowledge, in answer 13, "This retort was taken out of the furnace of the steam boiler used to drive the machinery in the Walker and Elm streets shop"?

A. No, I did not see the retort put in the furnace, nor did I see it taken out of the furnace. In fact, I

4173 did not see it at all, until old Mr. Sawyer called me to see the carbons, as I have stated.

139 x-Q. As I understand from your answer 132, you called at the shop and entered into a desultory conversation with Mr. Wm. E. Sawyer in the outer room of the shop, and that you went from there into the inner room, or workshop, to see the carbons when Mr. Sawyer called you?

A. Yes; that is as I recollect it.

140 x-Q. Would you call the inner room, or the
4174 outer room, the exhibition room?

A. The outer room is the room that I would call the exhibition room, although, it was probably as much of a workshop as the other one was. In the outer room every one was admitted who went to see Mr. Sawyer and whom Mr. Sawyer wanted to see. The door to the inner room was generally closed.

141 x-Q. I take it that at the time you gave your direct testimony in this case, your recollection was, that the retort unopened, and in a heated condition was
4175 brought into the outer, or exhibition room, and there opened in your presence; while I understand from your cross-examination that the retort was in the inner room, and had been opened before you saw it. Is your recollection, as to the matter of what took place at this visit, entirely clear?

A. Perhaps upon my examination-in-chief I did not appreciate the importance of fixing exactly the place where the box was opened, but as I think of what took place in following the details of the matter, I feel
4176 quite certain that Mr. Wm. E. Sawyer and I went into the inner room in answer to the call of the old man. I think I stated upon my examination-in-chief that the box was opened when the old man called to me. I think the only discrepancy between what I said on my examination-in-chief and what I have said on my cross-

examination is as to the room in which the box was 4177
opened, or in which we went to see the box. The old man may have opened the box in the outer room, but I don't see how it is material whether it was opened in the inner or the outer room, and I am perfectly clear now in reflecting upon the arrangement of the shop, that it was in the inner room that I saw the box after it was opened, because the box lay on the work-bench near the corner of the room, and there was no work-bench in the outer room on that side of the 4178
shop.

Adjourned till Friday, the 11th inst., at 11 A. M.

FRIDAY, January 11th, 1889.

Met.

Present—Counsel as before, and the cross-examina- 4179
tion of Mr. Broadnax was continued as follows:

142 x-Q. With reference to the carbons shown you on the occasion of your visit to the shop in Walker and Elm streets, and one of which was treated for you by Mr. Sawyer, was any electrical test made of these carbons to ascertain whether they differed in resistance to the extent that has been indicated by you?

A. I do not remember of my saying anything about the resistance of that or any carbon, nor do I 4180
remember of any test having been made to show the resistance of any of the carbons shown to me on that occasion.

143 x-Q. Was any electrical test made of these carbons, or any test whatever, except mere handling and inspection, to show that they differed in the degree of carbonization?

4181 A. Nothing was done to the carbons beyond what I have stated, that I remember of. No electrical measurement was made of any of them on that occasion to show the resistance or degrees of carbonization of any of them. It was some little time after that before I saw any of the carbons of Sawyer and Man subject to any tests of that kind.

144 x-Q. Was any electrical or other test made of the particular piece of carbon after it was treated?

4182 A. None that I have any knowledge of.

145 x-Q. In comparing the pieces of carbon that were in the retort, as you recollect it, you judged that the stiffer and less elastic pieces were better carbonized?

A. No, that is not a fair way to put it. My judgment upon the degree of carbonization of the several pieces that I examined was based upon the comparative density, smoothness and hardness of the several pieces. I took the carbons that were most dense and
4183 smooth to be those that were best carbonized.

146 x-Q. You judged wholly from the appearance to the eye?

A. Yes.

147 x-Q. What makes you think that the treatment in the hydro-carbon fluid resulted in improving the carbonization of the particular piece subjected to treatment?

A. Well, the mere fact that the current was passed through the carbon until it was raised to high incan-
4184 descence, was sufficient to satisfy my mind that the conductor subjected to that degree of heat must be pretty thoroughly carbonized, and my conclusion that it was more thoroughly carbonized was based upon the fact that the carbon was raised to high incandescence by a current.

148 x-Q. However, no test was made to determine

whether there had been any change in the degree of carbonization, and it was a mere matter of judgment on your part from the fact that the carbon was raised to incandescent by the current while immersed in the hydro carbon fluid? 4185

A. Yes, it was a mere matter of judgment, based on the fact I have named.

149 x-Q. You had no experience in determining the effect of the heat of an electric current upon a piece of carbon, had you? 4186

A. I don't recollect that I had ever before seen a piece of carbon raised to incandescence by an electric current

150 x-Q. There is no foundation, except in your judgment, formed without experience, for the statement contained in answer 116, that "It was well carbonized after it had been in the treating apparatus?"

A. The foundation for that statement is, as I have already said, based upon the fact that the carbon was raised to high incandescence. 4187

151 x-Q. What was the treating appartus employed by Mr. Sawyer on this occasion when he treated the carbon for you?

A. I don't know that I am able to describe it in detail. It was a glass receiver connected to a gas pipe and to the electric circuit. The carbon was held betwen the ends of the conductors leading into the receiver.

152 x-Q. Please describe the shape and size of the retort and its cover, and what the appearance of its 4188 contents was when you first saw it? I refer to the retort that you saw after it was opened, and from which a piece of carbon was taken and treated by Mr. Sawyer.

A. As I recollect the retort, it was what I think is called a small sized sand retort, such as are used for

4189 melting metal in by jewelers and others. I did not measure it, and I can only guess at the size. I should think it would be somewhere about two or three inches in diameter, and I should say it would be four or five inches deep. There was a flange about its upper end How the lid or cover was fastened on I did not notice. The retort was in the shape of a shallow frustum of a cone. It lay on its side on the bench, and the contents were raked out on the bench with a wire. The contents were composed of what appeared to be pow-
4190 dered carbon and the carbonized pieces of paper.

153 x-Q. The statement contained in your answer 6, that you "saw blank illuminants taken out of the box in which they had been carbonized," is based, I take it, upon the circumstances of the occasion that you have been testifying about when Mr. Sawyer took the piece of carbon out of the retort and treated it for you

A. Yes.

154 x-Q. What is the basis in fact for the state-
4191 ment contained in answer 6, that you "frequently saw the carbons treated," which, I take it, you intended to refer to paper carbons?

A. The basis for that statement is my experience in seeing the carbons treated.

155 x-Q. I take it the occasion that you have been testifying about when Mr. Sawyer treated the carbon for you is one basis for the statement quoted in my last question?

A. Yes, that was the first time I saw the carbons
4192 treated. Afterwards I very often saw them treat carbons..

156 x-Q. But that was the occasion when you followed the matter most closely?

A. That was the first and most interesting, because it was then entirely novel to me. After that I saw Sawyer treat carbons very often, but I had no special

interest after that in taking particular notice of the carbons, and the apparatus in which they were treated. 4193

157 x-Q. That was the occasion on which you had the best opportunity for determining of your own knowledge the character of the carbon treated, was it not?

A. No, I can't say that, because I had lots of opportunities, if I had chosen to avail myself of them, to go very fully into an investigation.

158 x-Q. But this was the occasion on which you took advantage of your opportunities, and on which you 4194
were best informed, of your own knowledge, of the character of the carbon treated?

A. That is the occasion upon which I went to see a thing done about which I have been talked to a good deal, and I took, therefore, personal cognizance, as I have already stated, of the carbons, the carbonization and treatment. I went to see what an incandescing conductor for an electric lamp made of carbonized paper was like, both before and after it was treated.
That being done, my mind was satisfied, and I made 4195
no further special examination of the matter. I frequently saw the treating afterwards, and carbons that had not been treated and those that had been treated, and had them in my hand, and talked about them a good deal to Sawyer and Man.

159 x-Q. But you think you have reason to believe that you knew of your own knowledge what the character of the carbon treated was better on this occasion than on subsequent occasions?

A. I knew of my own knowledge on that occasion 4196
what the carbons were made of. I knew that they were made of paper, and I saw them treated, and I frequently after saw carbons treated that were made of paper, or at least I have no doubt but that they were paper, although I did not see them put in the carbonizing box, nor did I see them taken out, but I am

4197 as well satisfied that they were paper as if I had seen the blank cut out of paper, carbonized and treated; as if I had stood by and witnessed the whole operation, because all the information I got upon the subject was from those in whose employ I was, in whose interest I was acting, and whose interest it was to tell me the truth, to the end that I might act intelligently in patenting their invention.

160 x-Q. My last question was based upon matters
4198 of your own knowledge. Cannot you give me a simple affirmative answer to it?

A. I know what my own knowledge was, without believing or reasoning upon the subject at all, and I have repeatedly stated what I know of my own knowledge. I know of my own knowledge what was done on the first occasion, but I do not know of my own knowledge how the paper was carbonized on any other occasion, or to what degree it was carbonized, nor how many of them were treated. A simple affirmative or
4199 negative answer to your question would infer all I knew of my own knowledge about this matter was based upon what I saw on that first occasion, which would not be the whole truth, because, in addition to what I saw on that first occasion, I frequently saw paper blanks that had not been carbonized. I saw the same blanks repeatedly afterwards, or blanks that looked just like them, that had been carbonized and afterwards treated, but on no other occasion did I stand by and see the carbons taken out of the retort,
4200 examine the lot of them before they were treated, and see them afterwards treated, all at one time. With this explanation, I answer your question directly in the affirmative.

Adjourned till 2 P. M.

Resumed after adjournment.

161 x-Q. Have you any distinct recollection of the circumstances of any later or subsequent occasion on which you saw carbons treated? 4201

A. None that I can distinguish especially. I frequently saw them treated as an incident of my visit to the works on some matter of business, but I cannot distinguish any particul r time.

162 x-Q. Can you recollect the circumstances?

A. I don't know that I can. I recollect being there once. I think some time in December, 1878, to see 4202
Mr. Sawyer, to get from him the operation of a dynamo electro machine that I was going to patent for him, and that at that time seeing them treat carbons, but I did not go there especially to se the carbons treated or worked with in any way. I had a special object in going there, and th t object was to see Mr. Sawyer and get him to explain his dynamo, and I don't recollect that I noted anything about the carbons or lamps that they were then making.

163 x-Q. Do you refer to the dynamo machine 4203
described in Sawyer's Patent No. 237,632, dated February 8, 1881, application filed December 20, 1878?

A. Yes, that is the one.

164 x-Q. You were preparing, or about to prepare, the application for the patent, I presume?

A. Yes, I think so, I did pr pare that application.

165 x-Q. You don't recollect investigating the matter of the treatment that was going on at the time of that visit in December?

A. Not by personal observation. 4204

166 x-Q. Did you not see the flask or vessel in which the treatment was being made?

A. I probably did, but I did not specially observe it. I knew they were treating carbons, but I don't know that I ever went over and looked at the apparatus. It

4205 was a thing I felt no interest in just then, and did no give it any attention.

167 x-Q. Do you recollect on any other occasion, except the first one, on which your observations were closer and more critical than on the occasion you have referred to in December, 1878?

A. No, I don't recollect of any.

168 x-Q. You understand the fact to be, do you not, that Sawyer and Man treated by their hydro-carbon treatment of other kinds of carbons than carbons
4206 from paper or fibrous material?

A. I understand that to be so, yes.

169 x-Q. What do you recollect, of your own knowledge, as to the actual putting of carbons into lamps by Sawyer and Man?

A. About the only knowledge I have of that consists of seeing old Mr. Sawyer put carbons in the lamps in assembling the several parts of the lamp. I saw him put carbons in the lamps, I think, on two or three occasions, but when these occasions were, I cannot tell
4207 the dates, or what took me to the shop at the time it was done.

170 x-Q. What kind of carbons were they?

A. They were straight pencils at one time, and U-shaped, or bow-shaped carbons, at another. What the carbons were made of I do not know, of my own knowledge. I merely inferred that the bow-shaped carbons were all fibrous carbons. The inference is due to the fact that, as I understand it, they did not make any bow-shaped carbons of anything excepting
4208 fibrous material at that time, I mean the fall of 1878.

171 x-Q. What were the straight carbons made of?

A. I don't know; I don't recollect of ever asking the question. I mean, of course, subsequent to the first time I saw them made and treated, as I have stated. I mean, of course, the first time I visited the works to

see the paper carbons, and did see them taken out of the retort carbonized, and one of them treated. 4209

172 x-Q. The bow-shaped carbons, I take it, were of the dug out character that you have described as being made by depositing carbon upon a core of fibrous carbon and then digging out the fibrous carbon?

A. Your question infers that all of the bow-shaped carbons were made in that way, an inference that has no foundation in fact. A few of them, or some of them, were made in that way, undoubtedly, but there were a 4210
great many of them made that were not dug out at all, and some of them, as I understand, were not even treated. I saw bow-shaped carbons that had not been treated at all, but whether they were treated before they were put in the lamps or not, I do not know, nor do I know whether those I saw put in the lamps were of the dug out variety. I do not recollect of observing whether they were dug out or not.

173 x-Q. Are you quite certain that you saw any bow-shaped carbons put in lamps? 4211

A. Yes, quite. I recollect distinctly of rallying old man Sawyer about the big clumsy clamps he had to hold the carbons.

174 x-Q. What was the character of the clamps?

A. These particular clamps were made of two pieces of carbon set vertically on the top of a leading conductor, and held together by a screw passing transversely through the two parts that composed the clamp and drawing them together on the ends of the illuminating conductor substantially as described in the pat- 4212
ent in suit.

175 x-Q. Do I understand that you now desire to change the position taken on your direct, and as stated in answers 6 and 7, that you did not see the paper or fibrous carbons "put in the lamp," and, as you ex-

4213 pressed it in other words, "did not see them (the different parts of the lamp) assembled?"

A. No; the thought that I intended to convey in my examination in chief, and that I intend to convey now, is that I never saw any paper carbons or fibrous carbons put in the lamps, that I knew to be fibrous carbons, excepting as I was informed by Sawyer and Man, or old Mr. Sawyer, William E. Sawyer's father, and when I said that I did not see the lamps assembled, I
4214 meant to say that I did not see them assembled as a whole, that is, put together and sealed up. The lamp was made in two principal parts, the leading-in conductors, and, indeed, all the machinery inside the lamp was fixed on a glass disc that closed the lower end of the globe. The carbons were put in the leading conductors so as to complete the circuit before the lamp as a whole was assembled, so that putting the carbons in the illuminating circuit was only a part, or the assembling of a part, of the lamp. When, in my exami-
4215 nation in chief, I said I did not see the lamp assembled, I meant all the parts of the lamp ready to put on the circuit.

176 x-Q. Then you mean by the expression, putting the carbon in the illuminating or lighting circuit, only the mounting of the carbon upon the leading-in conductors, and not the placing of the leading-in conductors within the lamp globe?

A. Yes, that is about what I meant. I suppose if I had remained I would have seen old Mr. Sawyer put
4216 all the parts together, that is, complete the assembling of the lamp.

177 x-Q. Am I right then in assuming that you did see Mr. Sawyer's father attach carbons to the leading-in wires, or place them in the lighting circuit, as you have expressed it, but did not see him complete the assembling of the lamps by placing the leading-in con-

ductors and carbons within the lamp globes and sealing such globes? 4217

A. Yes, that is substantially correct. The lamp could not be considered as assembled until all its parts necessary to make the lamp were brought together in their right relation. All that I saw the old man do was to put the U shaped carbons on the electrode leading into the lamp. Before these electrodes were put in the chamber or globe of the lamp they may have been altered, but whether they were or not, I don't know, I 4218
assume that they were not, but I don't know.

178 x Q. Do you wish to be understood that any of the carbons which you saw old Mr. Sawyer or anybody else connected with Sawyer and Man, or Sawyer and Man themselves, attach to the leading conductors, or in other words, put in the lighting circuit, were paper or fibrous carbons?

A. Yes, the old man told me that they were fibrous carbons. I don't know whether he said they were willow carbons or paper carbons. 4219

179 x-Q. Your position on that matter then is, that you did not see paper or fibrous carbons put into the lamps by Sawyer and Man or anybody for them, but that you did see such carbons attached to the leading conductors or put into the lighting circuit by old man Sawyer, who was working for Sawyer and Man?

A. That is substantially correct.

180 x-Q. Has your recollection of this matter changed since you gave your direct examination? You say at the beginning of answer 7 that "I did not see 4220
the illuminant put in the lighting circuit."

A. No, my recollection has not changed. What I said in the beginning of my answer to question 7 is exactly as it was in what I say now. I said then, "I mean that I did not see the illuminant put in the lighting circuit, and the lighting circuit put in the lamp. In short, I did not see the lamp made, but I

4221 did see the different parts of the lamp before they were assembled, and did see them after they were assembled, but did not see them being assembled," and that is exactly as it was.

181 x-Q. You mean to say now that you did see the illuminant put in the lighting circuit, but that you did not see the lighting circuit put in the lamp, and that you think is the meaning of answer 7, when all the matter quoted in your last answer is taken together?

A. Yes, I think so.

4222 182 x-Q. Speaking of the bow-shaped carbons which you saw old man Sawyer attach to wires, you say in answer 172 that you do not recollect observing whether they were dug out or not. Was your observation any closer with respect to the straight carbons which you saw put into the lighting circuit?

A. No; I don't think it was.

183 x-Q. In answer 7 you make the following statement:

4223 > "I desire to add also, that in the case of the straight pencil, it was a common practice for them to make the illuminants, by simply treating it slightly preparatory to using it in the lamp, leaving the fibrous carbon intact as part of the illuminant.

I take it from what you have said on cross-examination, as to your actual knowledge of the treating of carbons that was done by Sawyer and Man, and also from what you have said on cross-examination as to

4224 your actual knowledge of the putting of carbons into lamps, that this statement is not made of your own knowledge; am I right?

A. The exact fact about that is: Upon one of my visits at the shop some time during the period heretofore referred to by me; I mean between the middle of

October and middle of November or thereabouts; I 4225
saw some of these carbons that had the dug out appearance, and I asked what it was, and how it was done and it was explained to me, I think by Sawyer himself, how those carbons were made as I have already stated. I did not see any of them dug out, and there were only a few of them that were "dug out." The rest of them were intact, most of them had been treated, some very little, some a good deal. Those that had been treated only a little a little were not dug out. I will add I did not see these carbons made, and I did not see 4226
the operation of digging out the core.

184 x-Q. This then is the basis for the statement quoted in my last question?

A. Yes.

185 xQ. Did you examine these carbons very carefully?

A. I looked at them with a great deal of curiosity.

187 x-Q. Did you see any use made of them?

A. I don't remember that I did. I saw straight pencils of carbon that had evidently been made in that 4227
way in some of the lamps that had been used. But I don't recollect of seeing that particular kind of carbon illuminated in one of the lamps.

187 x-Q. Did you see these carbons before they were treated?

A. These particular carbons I never saw until I saw them in the condition I mention, but I saw a good many carbons that had not been treated.

188 x-Q. And you did not see these particular carbons treated? 4228

A. I have just said so.

189 x-Q. And you had means of telling of your own knowledge that the cores of these intact carbon pencils were made of?

A. No, only as I have stated.

4229 190 x-Q. That is from what Mr. Sawyer told you?

A. Yes.

Adjourned till Saturday, the 12th inst., at 11 A. M.

NEW YORK, January 12, 1889.

Met pursuant to adjournment. Present counsel as before, and the cross-examination of Mr. Broadnax was
4230 continued, as follows:

191 x-Q. What was the explanation made to you by Mr. Sawyer, which is referred to in your answer 183?

A. He explained to me how they were made.

192 x-Q. Was the entire explanation relating to these carbons of this character, i. e., and explanation of how they were made?

A. The explanation that he made, as I recollect it now, was merely that the carbons in question were made by first carbonizing a piece of paper, or other fib-
4231 rous material, so as make an illuminant complete in itself to fibrous materials to take that illuminant and treat it according to the Sawyer-Man Patent 211,262, until they had upon it as thick a deposit of carbon made by that process as they wanted, that a longitudinal section of the deposit carbon was then cut away from the illuminant, sufficient to expose the firous carbon core, which was then dug out, by which there was left an illuminant of deposit carbon in the form of a trough. That is the substance of the explanation, without pretend-
4232 ing to give the language used by Mr. Sawyer in making the explanation.

193 x-Q. And is that the substance of the entire explanation, or substantially all of it?

A. That is the substance of the whole explanation, as I now recollect it, and it was sufficient to convey to my mind how the carbon was made.

194 x-Q. The only occasion on which you saw carbons introduced into the lighting circuit by Sawyer and 4233
Man, or attached to the conductors, were the occasions about which you have testified in answer to cross-questions 169 to 182, inclusive?

A. I cannot say that those were the only occasions. I recollect of seeing old Mr. Sawyer put the bow-shaped carbons in lamps having carbon clamps on the upper ends of the leading-in conductors, like the patent in suit, and I recollect, also, seeing the same kind 4234
of carbons set in the upper ends of the leading-in conductors, the holders being made like those in "Exhibit Lamp No. 2." I was at the shop quite often, and saw them working on different parts of the lamp. How often I cannot say, nor can I say just how often I saw them putting carbons in the lighting circuit.

195 x-Q. Referring now to "Exhibit No. 2," introduced in your direct answer 18, this structure has the brass cup not fitted upon the bottom of the lamp, and not filled with any sealing material. Am I right? 4235

A. The brass cup, or cap, which is intended as the final sealing of the lamp, has been fitted to the base but it is not pressed up to its proper place. The cup is not filled, nor does it contain any sealing material, but is simply stuck on the base of the lamp.

196 x-Q. This then is not a completed lamp in its present condition?

A. No.

197 x-Q. There is no carbon illuminant within the lamp?

A. No, there is none. 4236

198 x-Q. And no loose pieces of carbon within the lamp to show that it was even provided with an illuminant?

A. There are no loose pieces of carbon in the lamp that I am able to discover.

4237

199 x-Q. And the blocks of carbon above the soap-stone disc are not burnt or discolored in such a way as they would be if an illuminant had been burnt out between them?

A. The carbon holders in this lamp do not seem to be discolored but very little around the edges of the creases cut to receive the carbon illuminants.

200 x-Q. There are no evidences of a carbonaceous or other cement having been used to attach an illuminant to the blocks of carbon in this lamp?

4238 A. I don't see any carbon cement upon the carbon holders.

201 x-Q. What are the holes in the periphery of the soap-stone disc intended for?

A. They are intended, and the lamp was so made as a rule, to receive spiral springs to keep the soap-stone disc from knocking against the globe of the lamp.

202 x-Q. Has this "Exhibit No. 2," any such springs?

A. I don't see any.

4239 203 x-Q. You did not intend by your answer to question 18 to state that this lamp No. 2 has an illuminant in it of bow shape or any other shape?

A. No, I did not, I merely produced that lamp as one of a kind in which I saw the U shaped carbons put. I did not intend to say, and don't think I did say that I had seen the U shaped fibrous carbon in this particular lamp. I produced this lamp because it was the only one I had of the kind of lamps or type of lamps in which the bow shaped carbon was used;

4240 whether there was ever a carbon illuminant in this particular lamp I don't know.

204 x-Q. And there is nothing in the appearance of this "Exhibit No. 2," to indicate that a carbon illuminant of any character has been secured to the carbon blocks by means of a carbonaceous cement or any other kind of a cement, is there?

A. Well, I am not willing to swear that there has never been any carbon illuminant in this lamp secured by a carbonaceous cement, because I don't know what the appearance of the lamp would be if there had been. I am not sufficiently familiar with the appearance of the illuminant holders and the glass globe of the lamp in which illuminants have been placed to make my judgment of any value in that respect. 4241

Adjourned till Tuesday, the 15th inst., at 11 A. M.

4242

New York, January 15th, 1889.

Met pursuant to adjournment. Present counsel as before, and the cross-examination of Mr. Broadnax continued as follows:

205 x-Q. As I recollect, your testimony in cross-examination as to the particular occasion when Mr. Sawyer treated a straight piece of carbon for you, you do not recollect the construction of the apparatus used by 4243
him in the treating operation?

A. Only in a general way, as I stated; I could not give a detailed description of it.

206 x-Q. And, as I understand from your answers to cross-questions 161, 162, 166 and 167, you did not afterwards observe the treating process and apparatus as critically as on this first occassion, and have no better recollection about the treating apparatus subsequently employed?

A. No, I don't know that I could describe it. In 4244
fact, I know I could not give any better description of it than I have already done.

207 x-Q. Your recollection, I take it, as to the treating apparatus used on the first occasion, when you examined it especially, is only general, that it was a glass vessel with a gas connection and some arrange-

4245 ment for holding the the piece of carbon within the vessel filled with the gas?

A. I think I described it in my examination in chief as consisting of a glass receiving chamber having a glass bottom or enclosing cover in which there was fitted a receiving nozzle or pipe through which the gas entered into the chamber, and an exit pipe through which the gas escaped from the chamber, and also conducting wires leading to and from the chamber, having on their upper ends a device for holding the carbons
4246 to be treated. That, I think, is the whole apparatus substantially. Just what the detail of the fitting was I can't describe, because I don't remember.

208 x-Q. The apparatus of that first occasion was not the same as Complainant's Exhibit Sawyer-Man treating apparatus, which you described in direct answer 12, and which is introduced in evidence after direct answer 19, was it?

A. It was similar to this, but not exactly like it. I think the lower part of it was the same. The upper
4247 part of it for holding the carbon to be treated was different. Some arrangement was made, that I don't now recollect, for holding the straight carbon vertically, one of the metallic electrodes being longer than the other. I recollect the carbon standing vertically in the receiver, but I cannot remember how it was fixed.

209 x-Q. That exhibit then is not the apparatus, in all respects at least, which you saw used for treating?

A. Substantially it is, all except the little mechanical detail for holding the straight carbon. This is the
4248 apparatus, or one like it, which was used for treating the bow or U shaped carbons.

210 x-Q. The holders or clamps of that exhibit are not so located as relatively as to be suitable for holding a straight pencil two inches long or thereabouts, such as you have testified you saw treated?

4249 A. No, I think not.

211 x-Q. Do you wish by your answer to cross-question 209, to recede from the position taken in answers to cross-question 161, 162, 166 and 167, that you did not observe the character of the treating apparatus on occasions subsequent to this first occasion?

A. No, I don't mean to recede from any position I have taken. I have not specified the particular occasion upon which I saw this apparatus, Exhibit Sawyer-Man, treating apparatus used for treating U shaped car- 4250
bons. I recollect seeing them treat with an appartus like this, or something like this, the U shaped carbons.

212 x-Q. In answer to cross-question 166, you state, referring to a definite visit to the shop in December, 1878,

> "I knew they were treating carbons, but I don't know that I even went over and looked at the apparatus,"

and in answer to cross 167, you state that you do not 4251
recollect any occasion, except the first one, when Sawyer treated the straight carbon for you, on which your observations were closer and more critical than at the time of the December visit. Do I understand that you now mean to say that there were after occasions besides the first one, when the straight carbon was treated, on which other occasions you did not go over and look at the apparatus?

A. I don't recollect just now of any occasion subsequent to December when I paid any attention to any 4252
particular treating apparatus, although I may have done so. I have a very distinct recollection of seeing Sawyer treat the straight carbon pencil, as I have stated, and I recollect, also, of seeing the U-shaped carbons treated in apparatus something like this exhibit. Whether it was exactly like that I could not tell, but it was substantially that. When I said in the previous

4253 answer that I did not recollect of observing particularly on any other occasion the treating apparatus, I meant subsequently to that visit in December. In fact, it is impossible for me now to distinguish the times when I saw these things done at the shop of Sawyer and Man.

213 x-Q. Did you recollect at the time of answering cross-questions 161 to 167 inclusive any time, whether before or after December, 1878, on which you did see
4254 the carbons treated and did look at the apparatus?

A. No, I don't know as I had the element of time just then in my mind at all, not thinking it was of any importance whether I saw it before or after my December visit. I know that I saw these things take place, but the order of them I can't recollect at all.

214 x-Q. If, as you now state, you did not at the time of answering questions 161 to 167, think it was of any importance whether you saw the treating before or after your December visit (as you were justified in
4255 thinking, since those questions call for all occasions, and not for occasions after or before any particular time), why did you by your answer to cross-question 212 attempt to avoid the effect of your answers to cross 161 to 167 inclusive, by stating that in answering cross-question 167 you were referring to occasions subsequent to your visit in December?

A. I don't know that I quite understand the question, it is so very involved, but I had no idea in answering the question I understand you to refer to, of
4256 seeking to evade the effect of anything I have said. I merely meant to explain, or rather to state, what occurred to me in connection with the question at that time. It occurred to me then that I did not recollect, at least, I could not call to mind, any special occasion that I saw him treating them, or observed any treating apparatus subsequent to my visit in December, because,

4257 as I now recollect it, my visits to the works were quite infrequent towards the latter part of December and January.

215 x-Q. Do you now wish to recede from the position taken in answer to cross 213, that in answering cross-question 161 to 167 inclusive, you did not have the element of time in mind, and did not think it of importance whether you saw the treating before or after your December visit?

A. No, I don't mean to recede from anything. 4258

216 x-Q. Your answer to cross-question 213 then is correct?

A. Generally speaking, I think my answers are all correct. I recollect, as I have already stated, and now repeat, of observing, in a general way, the treatment of the carbon that I first saw treated by Mr. Sawyer, the straight pencils, and I recollect, also, of seeing treated (whether Sawyer did it or not, I don't now recollect, but I don't think Sawyer did it, I think it was somebody else) the U-shaped carbons, and I recol- 4259
lect of being there in December when they were treating carbons, but I don't recollect that I went to look particularly at the apparatus or method of treating. The fact of these things being done, I recollect, but the order in which they were done, I don't recollect, nor do I recollect the minute detail of any of the apparatus. When I said that I did not recollect of any other occasion when I had examined more minutely the apparatus, I did not have in my mind at all the apparatus that I described in my examination in chief. 4260

217 x-Q. Then it is true, as stated in your answer to cross-question 213, that when you answered cross-questions 161 to 167 inclusive, you did not have the element of time in mind, and did not think it important for the purposes of those questions, whether the occasions were after or before your December visit?

4261 A. No; I don't see how it could be important in any respect of the matter whether it was before or after my December visit. I certainly don't recollect so as to be able to distinguish them, of seeing any treating done that I specially noticed subsequent to December, nor do I recollect. If I said that I did not have the element of time in my mind when I answered any question, it is true.

4262 Adjourned till 2 o'clock.

Resumed after adjournment.

218 x-Q. I still take it that your answer to cross-questions, 161 to 167 are substantially correct, and that your examination of the apparatus when Sawyer treated the straight carbon for you, was more thorough and critical than any subsequent observations of the treating apparatus?

4263 A. Whatever I have said is *intended* to be exactly right, and to avoid the possibility of appearing to mislead, I will state that there are only two occasions that I recollect of upon which I observed at all the treating apparatus, and on neither of those occasions did I make a critical examination of them. I saw, in a general way, that they were. One of those occasions I described on my examination in chief, where I described the treatment of the U-shaped carbon and the apparatus in a general way, used in treating them, and
4264 the other was the treatment of the straight carbon by Sawyer, that I described on my cross-examination, that did not occur to me when I was testifying in chief and when I was asked by you whether there was any other occasion on which I had more carefully observed the treating apparatus, I took it for granted that you intended to ask me whether there was any other

occasion than those which I had referred to, on which I had more carefully examined the treating apparatus, to which I answered in the negative, but I did not then intend to exclude the occasion referred to on my examination in chief. 4265

219 x-Q. What is there in cross-question 167 which led you to believe that I excluded any occasion referred to in your direct?

A. I don't know that there is anything in terms in the question, but it seems fair to assume that, after I had testified about the occasion mentioned in my ex- 4266
amination in chief, you did not intend to exclude that occasion from your question, and I answered the question rather to meet the substance, perhaps, of the question than its terms.

220 x-Q. Please point out where, in your direct examination, you have testified to any particular occasion on which you saw carbons treated?

A. In answer to question 12, in my examination in chief, I described an occasion on which I saw an apparatus used in treating U-shaped carbons, substanti- 4267
ally like that which I have produced. I did not state any particular time when I saw that, because I could not recollect exactly the time when it occurred, but it is plain from the examination that it was on a different occasion, or at a different time from that mentioned on the cross-examination, when the straight carbon was treated by Mr. Sawyer.

221 x-Q. Where, in answer 12, is any mention made of the U-shape carbon?

A. I don't know, and do not find in the answer re- 4268
ferred to that the word U shaped carbon is used but in the apparatus produced only U shaped carbons could be treated, as I understand it, and I stated in that answer that in "these clamps the two ends of the carbon to be treated were secured so as to complete the circuit in the lamp."

4269

222 x-Q. Could not a straight piece of carbon be secured by the clamps of this exhibit Sawyer-Man treating apparatus?

A. I don't see how a straight pencil could be treated in that apparatus, although it might be possible.

223 x-Q. What would prevent the clamps being opened and a straight piece of carbon laid right across them, and then being secured by the tightening of the nuts of the clamps?

4270 A. The carbon holders are very near together, so that no straight pencil could be treated in them, unless it might be a very short one, unless the structure of the apparatus was changed?

224 x-Q. That is, a straight piece of carbon could be readily secured by the clamps of the exhibit, but its exposed incandescent body would be in length equal only to the distance between the clamps?

A. Yes, that is among the possibilities, but I have no idea that such a thing was ever done with this ap-
4271 paratus, or that the apparatus was made for anything of that kind, and it certainly was not used by Mr. Sawyer in treating a straight pencil as I have described. He had some of a device in which he held the pencil vertical in the lighting circuit.

325 x-Q. As I understand, and from your cross-examination, you do not know that this exhibit Sawyer-Man treating apparatus was ever seen by you in use, but that you belived it to be subtantially the same in construction as the corresponding part of the treating
4272 apparatus that you did see in use?

A. Yes, that is substantially what I mean. I don't know that I saw that particular apparatus in use?

126 x-Q. And you do not wish your answer to question 12 to be taken as going any further in that direction than your last answer?

A. What I meant to say was, that I had seen the

4273

U-shaped carbons treated in an apparatus that was substantially like that. Whether that is the identical apparatus in which I saw them treated or not, I do not know.

227 x-Q. How did the "Exhibit Sawyer-Man Treating Apparatus" come into your possession, and when?

A. Mr. Albon Man gave it to me in the early part of last summer, or in the latter part of the Spring of 1883, as the apparatus in which he and Sawyer treated their U-shaped carbons. He gave it to me at his house, I 4274
was there looking over a lot of apparatus of different kinds that he and Sawyer had used in making their electric lamps.

228 x-Q. You were taking testimony at that time in a suit on the same patent which is involved in this suit, brought by the complainant against the Edison Electric Light Co. in the U. S. Circuit Court for the Southern District of New York No. 3,553?

A. We either were taking testimony in that suit, or had been. My impression is that I got that exhibit 4275
before the complainant in that case closed their affirmative proofs.

229 x-Q. Referring to the Sawyer-Man lamps which you saw in 1878 and 1879, were such lamps ever sold or used commercially?

A. I don't know whether they were or not.

230 x-Q. Your association with the officers and directors of the Electric Dynamic Light Co. was an intimate one, was it not?

A. With some of them, Mr. Man, Mr. Sawyer and 4276
Mr. Jacob Hays, I had a good deal of intercourse, but my intercourse was limited to such matters as appertained to the patents of the Company. In short, it was a professional one, and more with Mr. Man than any of the rest, although I was in frequent intercourse with Mr. Sawyer.

4277

231 x-Q. If that Company had done a commercial business it would have come to your attention, would it not?

A. Well it might, and it might not. They may have made and sold lots of lamps without my knowing anything about it.

232 x-Q. How long did you see any of the lamps lighted at any time?

A. I don't know how long. I saw the lamps lighted, more or less of them on almost every occasion when I
4278 went to the works, but I don't remember to ever have been there more than an hour or an hour and a half at any one time when the lamps were illuminated. I was there upon one occasion when there was a number of other gentlemen, when there was a number of lamps illuminated. That probably was the longest time I ever saw the lamps illuminated, and looking at it from this length of time, I don't think it was over an hour.

233 x-Q. What was this occasion, when was it, and who were present?

4279 A. I don't know who all were present, Mr. Hays, Mr. Myers, Mr. Man, and I think Mr. Judd and others, whose names I don't know. At least I don't recollect them, if I ever did know. There was an exposition of the lamps there, broad shutters were put over the windows of the outside room, and a very brilliant illumination of the lamps was had. It was some time in the fall of 1878. I should think it was some time in November, it might have been in December.

234 x-Q. What was the purpose of the exhibition, if
4280 you know?

A. I don't know that I ever asked what its purpose was, and I don't know that I was ever told what its purpose was, but I inferred that it was to show the lamps to the gentlemen interested, and to others who were invited to see it. I think it was mentioned in the newspapers of the day.

4281

235 x-Q. This exhibition was in the outer room of the shop, I take it?

A. Yes.

236 x-Q. Please state how the lamps were arranged and supported, and how many of them were lighted at one time?

A. There was a chandelier hanging pendent in the center of the room, on which there were three lamps, two standing upright and one hanging pendent, and there were around the walls of the room a number of lamps 4282
supported in brackets. I don't know how many were there. I don't recollect now, but I have an impression, but it is only an impression, that there were eight lamps in circuit altogether, and they were all illuminated at one time, that were in circuit, and continued to be so illuminated during my stay there.

237 x-Q. Referring to your answers to direct questions 9 and 10, did you know how long the Sawyer and Man lamps would last without burning out the carbons?

A. No. 4283

238 x-Q. Or how long they would last without requiring a recharging of the globes?

A. No, all the knowledge I have on that subject is mere hearsay information.

239 x-Q. Or whether such lamps were capable of being economically operated?

A. I do not know anything about the economy of their operation.

240 x-Q. Or did you know whether they were capable of being used for practical illumination without re- 4284
quiring conductors of such large size as to make their use commercially prohibitive?

(Objected to as incompetent.)

A. Those are things about which I had no knowledge at that time.

Adjourned till Wednesday, 16th inst., at 11 A. M.

4285

NEW YORK, January 16, 1889.

Met pursuant to adjournment. Present counsel as before, and the cross-examination of Mr. Broadnax proceeded, as follows:

241 x-Q. Referring to the following patents granted to William E. Sawyer and Albon Man:

NUMBER.	DATE.	TITLE.
205,144	June 18, 1878.	Electric Lamp
4286 205,303	June 25, 1878.	Electric Lighting System
205,305.	June 25, 1878.	Regulator for Electric Lights

the applications for which patents were all filed in May, 1878, did you prepare or prosecute these applications for patents?

A. No, I did not prepare them, nor did I prosecute them, or have anything to do with the prosecution of them. The patents referred to were all issued before I was retained by the Electric Dynamic Light Co., or by Sawyer and Man.

4287 242 x-Q. Referring to the following patents granted to Wm. E. Sawyer and Albon Man:

NUMBER.	DATE.	TITLE.
210,152	Nov. 19, 1878.	Switch for Electric Light.
210,809	Dec. 10, 1878.	Electric Lamp.
211,262	Jan. 7, 1879.	Carbons for Electric Lights.
229,335	June 29, 1880.	" " " "
229,476	" " "	Electric Switch.

The applications for all of which patents were filed in 1878; did you prepare or prosecute these applica-
4288 tions?

A. I prepared and prosecuted the applications for all the patents mentioned in the question.

243 x-Q. Did you prepare and prosecute the application for the reissue of said Patent 205,303, which reissue application was filed May 14, 1881, and resulted in reissue Patent No. 10,134, dated June 6, 1882?

4289

A. I did.

244 x-Q. Do you know of any other patents granted upon joint inventions of Sawyer and Man, or applications for patents filed upon joint inventions of Sawyer and Man, other than those mentioned in my last three questions, and excepting of course, the patent in suit?

A. I do not recollect of any just now.

Counsel for defendant offers in evidence the patents of Sawyer and Man, referred to in questions 241, 242 and 243, and the same are marked respectively, "Defendants Exhibits, 4290
Sawyer-Man patent No. 210,152, 210,809, 211,262, 229,335, 229,476, 205,144, 205,303, 205,305 and reissue No. 10,134, all of Jan. 16, 1889.

It is stipulated between counsel that ordinary Patent Office copies of the specifications and drawings of said patents, may be marked in evidence, with the same force and effect as certified copies of such patents, subject to correction if any mistake should be discover- 4291
ed in such copies.

245 x-Q. Then, so far as you now recollect you prepared and prosecuted all applications for patents upon the joint inventions of Sawyer and Man, except the application for the patent in suit, and except the three patents which were applied for and granted before you were retained?

A. Yes, that is correct. My connection with the preparation and prosecution of the patent in suit, I 4292
have already explained.

246 x-Q. I understand that you drew the assignment of Sawyer and Man, to the Electro Dynamic Light Co., dated Oct. 14. 1878, and marked as an exhibit in this case?

A. I did.

4293 247 x-Q. I take it that that assignment was intended to cover the inventions which had been described to you at the interview, you have testified about occurring before the date of this assignment, and upon which you had prepared, or intended to prepare, applications for patents?

A. Yes, that assignment was intended to convey the inventions of the switch, of the carbons, and of the method of treating the carbons. It was made before
4294 the applications for the patents were made, and was intended to cover all their inventions in carbons, as well as in their methods of treating carbons, as well as in electric lighting apparatus, and circuits. The language of the assignment was made broad and general, being made before the applications were made; the plan being to make additional assignments of the patents as soon as they were issued, or at the time the applications were made for each patent, to authorize the Commissioner of Patents, among other things, to issue the
4295 patents to the assignee.

248 x-Q. The application for Patent No. 211,262 was prepared at least as early as the date of this assignment, was it not?

A. It was somewhat about that time. I don't recollect exactly the date. I think the application was prepared before the assignment was made.

249 x-Q. It appears that the title of the first improvement mentioned in the assignment is an exact quotation of the title which you gave the invention in
4296 the preamble of the specification of Patent No. 210,-152. Was not this application prepared, or at least its preparation commenced, to a sufficient extent to determine the title you would give the invention, before the execution of the assignment?

A. Yes, I think so.

250 x-Q. And, I take it, that the titles are quoted in

the assignment from the titles which you had given the applications? 4297

A. Well, I presume so, although I have no recollection of the fact at this time.

251 x-Q. It is a fact, is it not, that the title quoted in the assignment in the paragraph beginning "secondly," at the beginning of the assignment, is the precise title that is found in the preamble of the specification of Patent No. 211,262?

A. Yes, the title of the patent referred to, as it ap- 4298
pears in the first paragraph of the specification, is in the following language: "Improvements in carbons for electric lights."

252 x-Q. And it is a fact, is it not, that said Patent No. 211,262 describes not only improvements in carbons for electric lights, but also in the treatment thereof?

A. Yes, I think it does, but of course the best evidence of what is in the patent will appear by the patent itself. 4299

253 x-Q. It is a fact, is it not, that when the application was filled upon which Patent 211,262 was granted, the application claimed not only the invention of treating carbons, but also the invention of the carbons themselves, as a new article of manufacture, and that before the patent issued, the claim or claims upon the latter invention were erased, and were embodied in the application which afterwards became Patents No. 229,335?

A. It is a fact that at the time that application was 4300
prepared the process of treating the carbon was described and claimed, and so also was the product of that process, and there it stopped. The idea of making carbon for electric lights in any other way than that described by the patent is not even referred to. Subsequently to the filing of the application it was divided, and another and separate application was filed

4301 for the product of the process, making two separate patents for the subject matter described in the original specification, filed October 15, 1878.

254 x-Q. And that separate application resulted in Patent No. 229,335?

A. Yes.

Adjourned till 2 o'clock.

Resumed after adjournment.

255 x-Q. Did you retain any copy of the specifications prepared by you on the fibrous carbon in April,
4302 1879, or memorandum of claims you made in that specification?

A. No, I did not. That specification was, as I think I have stated, in lead pencil, on buff drafting paper, and was a draft submitted to Sawyer for revision.

256 x-Q. How complete was it?

A. It was a complete specification.

257 x-Q. I take it that it was simply a pencil draft of the specification and claims, and did not include the petition and oath which are necessary for a complete
4303 application?

A. Yes, that is correct. It was not an application submitted for execution, but a specification submitted for examination and revision.

258 x-Q. Did you ever prepare complete papers for an application on that invention?

A. No.

259 x-Q. You do not know whether that pencil draft was employed to any extent in the preparation of the application for the patent in suit?

4304 A. I do not.

260 x-Q. Why did you not prepare this application and have it executed and filed in October, 1878, as you did the applications upon which Patents No. 210,152 and 211,162 were issued?

A. The application for that patent was delayed primarily for the reason that I was not able to under-

stand how a carbon made of paper or wood was patentable in itself without reference to any combination that it might be united into. Man was very strenuous in his insistance that the invention, by which I mean the carbon itself, was patentable broadly. I recollect of taking down and reading the decision of the Supreme Court in the case of Hotchkiss vs. Greenwood, at the time I was discussing with Sawyer and Man the patentability of this invention. A good deal of discussion grew out of the question then between Man and 4306
I as to whether that was a parallel case. I cannot tell now what the arguments were that were advanced pro and con, but it resulted in postponing the matter for further reflection, consideration and investigation on my part, and so the thing, being postponed, ran along from time to time, I visiting their workshop and seeing the carbons made, until finally I made the draft of the specification, which I gave to Sawyer, as I have already stated, not thinking there was any danger in the short delay that would ensue before I could make up my 4307
mind what shape to put the application in, I mean the specification. I was very busy in the meantime on the business of the Electro-Dynamic Light Co. and others in applying for patents and prosecuting them, both in this country and in Europe.

261 x-Q. In that draft did you attempt to overcome the obstacles raised in your mind by the decision in Hotchkiss vs. Greenwood?

A. I do not like to swear to what I put into that specification at this time, because I do not recollect what 4308
all was in it. I went over the case pretty freely, putting into it all that I thought might possibly be made available. I made up my mind, as I recollect in a general way now, that I would claim the invention and its application as broadly as I could, and see what would come of it on examination in the Patent Office,

4309 knowing, of course, that I could cut it down or revise it, if that should be necessary.

262 x-Q. You held the opinion at that time, and insisted upon it in your arguments and briefs afterwards in the interference case, that the material, independent of the form, was not patentable, did you not?

A. I did, but I did so in my ignorance of the properties possessed by such carbons, which made it available as an illuminant above all other carbons, so far as
4310 I know. Of course I speak of it now as a carbon illuminant, made from carbonized paper or other fibrous material, and in the light of information subsequently acquired.

263 x-Q. But at the time of the disclosure of the invention to you, in the fall of 1878, and continuing through the arguments in the interference case as late as 1884, you held the opinion that the carbon of paper or other fibrous material of itself was not patentable, but that such a carbon in the form of an arc or loop
4311 was patentable?

A. From the time this invention was first brought to me to patent, down to the time that I finally argued the issues upon the interference case before the Commissioner of Patents in person, I believed that the U-shaped or loop-shaped carbon illuminant included in the lighting circuit of the lamp was new, irrespective of the kind of carbon it was made of, and I took the ground, in my ignorance of the properties that this particular material as an illuminant possessed, that it
4312 was a substitution of one carbon for another, that is, without taking into account the U-shaped form of the carbon, and considering the matter broadly, without reference to its form or combination.

264 x-Q. When were your views on this subject changed?

A. After the decision of the Commissioner of

Patents of the interference, awarding priority of invention to Sawyer and Man, I resumed the prosecution of the application, insisting upon our right to the claims that had been once rejected by the Examiner, among which was one for the U-shaped or loop carbon illuminant. My attention was then called for the first time by the Examiner to the British patent of Konn, in which is shown an arch-shaped carbon illuminant, and which, as I thought, anticipated broadly the claim for the U-shaped or arch-shaped carbon illuminant, 4314
and then, in the discussion of the case with the Examiner, my attention was called to the patentability of the fibrous carbon illuminant as such, on account of the properties such carbon possessed, which made it available for electric lighting above all other carbons. 4313

265 x-Q. About when was this?

A. It followed very soon after the decision of the Commissioner of Patents upon the question of priority, or as soon as I could in the ordinary course get the case before the Primary Examiner again, according to 4315
the practice in the Patent Office. My best recollection is that it occurred in February, 1885.

266 x-Q. What is the name of the Examiner with whom this discussion was had?

A. I think the name of one of the Assistant Examiners was Lyon, with whom I discussed that matter, and I discussed it also with one of the other assistants, as it seems to me, whose name I don't now recollect, and also with the Examiner in charge of that class. I think his name was Kintner. 4316

267 x-Q. You have stated that the preparation of the application on the U-shaped fibrous carbon was delayed to give you further time to consider and investigate the matter. Do you recollect the fact that Albon Man, one of the joint inventors named in that application, has testified that you advised them not to

4317 apply for the patent in the fall of 1878, when you were consulted, but advised them to make further experiments?

A. I have not the deposition of Albon Man before me, and I cannot, therefore, know exactly what he said, but it is a fact that I advised the postponement of the application until I could have time to see the carbons made and tried, and further time for reflection; and I can't conceive of Albon Man's swearing to anything that was not corroborative of that statement, but
4318 whatever he did say will appear by the record.

268 x-Q. Do you not recollect of Mr. Man's giving the testimony I have referred to?

A. I recollect of Mr. Man's testifying upon the matter, and now that you have put in my hands the deposition of Albon Man, I do not see anything in it that is repugnant to or contradictory of my statement. We had a great many interviews upon the subject, but what was said at these several interviews I cannot remember, and I don't think that Albon Man can; but
4319 the broad fact that I wanted the application postponed, as I have stated, until further light could be obtained by me upon the matter, by observation and investigation, seems to be clearly remembered by Mr. Man, as well as myself.

269 x-Q. In a suit brought by complainant against the Edison Electric Light Co., in the U. S. Circuit Court for the Southern District of New York, on Patent No. 211,262; you acted as counsel for complainant, did you not?

4320 Objected to as incompetent.

A. In equity suit No. 3,406, in this Court I appeared, as counsel for complainant. That suit was founded upon the patent referred to in the question, and against the Edison Electric Light Co.

Adjourned till Wednesday, the 17th inst., at 11 A M.

4321

NEW YORK, January 17th, 1889.

Met, pursuant to adjournment. Present counsel as before, and the cross-examination of Mr. Broadnax continued, as follows:

270 x-Q. And in that case you took the testimony of Albon Man for the complainant?

Objection continued.

A. I did. 4322

271 x-Q. Do you recollect that the witness, Albon Man, in answer to the following questions, on cross-examination, made the following answers:

"353 x-Q. Are you able to remember a single instance in which counsel was consulted in regard to obtaining a patent on any invention, and advised you not to apply for it?

Same objecitons.

4323

A. Yes, sir.

"354 x-Q. Was that counsel Mr. Broadnax?

Same objections.

A. Yes, sir.

255 x-Q. "What were his reasons for advising you not to apply for the patent?

Same objections.

A. One case I have specially in mind had reference to a proposed application for fibrous 4324 carbon, particulary fibrous carbon made from paper, in regard to which he was consulted early in the Fall of 1878, as to which he advised at the time further experiments; afterwards further postponements of the subject matter."

4325 365 x-Q. Why did he advise further experiments?

Same objections, and further, as calling for a confidential communication between counsel and client, and the witness is instructed not to answer. Further objected to as incompetent, immaterial and not cross-examination; that the question is not material, either as cross-examination or examination in chief to
4326 any of the issues in this case, and the same is true of the whole of the so-called cross-examination; the witness is submitted for cross-examination and will answer fully and fairly any and all questions in cross-examination.

A. I am directed not to answer."

A. I recollect Albon Man's testifying in the case referred to, but what questions were asked him by the cross-examining counsel I do not remember, nor do I
4327 remember what answers he gave to any questions propounded to him. The record in the case will, of course, show what questions and answers were made.

272 x-Q. Do you not recollect that Albon Man testified in that case that he consulted you with regard to applying for a patent for the fibrous carbon in the Fall of 1878, and that you advised him to delay applying for the patent and to make further experiments?

A. No, I don't recollect it out of my own memory, but I see it here printed as part of Albon Man's de-
4328 position in the case referred to, and I have no doubt that the questions were propounded and the answers made, as stated in this printed copy of the record, and as quoted by you therefrom, but I can hardly be expected to remember any particular question or answer in a deposition covering over 300 pages of printed matter.

4329

273 x-Q. Do you not recollect giving the instruction to the witness, Albon Man, not to answer, which occurs after 365 x-Q. of that record, and which is quoted in answer to my question 271 in this record?

Objected to as incompetent.

A. I recollect of instructing Mr. Albon Man not to answer on several occasions during that cross-examination, but I don't recollect any particular occasion. Upon reaking this record, I have no doubt I did give 4330
this instruction therein recorded.

274 x-Q. You have stated that you do not think that after the great lapse of time, either you or Albon Man can recollect "what was said at these several interviews" with regard to the reasons for delaying applying for the patent upon the fibrous carbon. You, yourself, have testified in this case as to some reasons which you recollect. Do you consider the reason given by Albon Man in his testimony quoted in cross-question 271, as inconsistent with the reasons which you have 4331
given as a part or your recollection?

A. No; I do not consider that there is any inconsistency between Mr. Man's testimony and mine on that point.

275 x-Q. It would be a fair interpretation of Mr. Man's testimony, and of your own, that you have given some reasons which you recollect, while Mr. Man has given additional reasons which he recollects, would it not?

A. No; I don't think it would be. I think that the 4332
substance of Mr. Man's testimony is, that I advised postponements and further experiments, for the purpose of obtaining for me further light and knowledge of the subject under consideration. That is the substance of my own testimony, and that is the fact.

276 x-Q. Please state your entire connection with

4333 the preparation of the application which was filed on January 9, 1880, and resulted in the pending suit?

A. I had absolutely nothing to do with the preparation of that application, unless my presence in the office of Mr. Cheever, when the application was executed by Mr. Man might be said to be a participation.

277 x-Q. Were you not consulted by Man?

A. I was not consulted by Mr. Man, nor any one else about that application, and I did not know any-
4334 thing about it more than two hours before it was executed.

Adjourned till 2 o'clock P. M.

Resumed after adjournment.

278 x-Q. Why were you present at Mr. Cheever's office?

A. Mr. Man called at my office and requested me to go there with him, and I went with him, and Mr. Man
4335 told me what he was about to do on the way from my office to Mr. Cheever's office.

279 x-Q. What did he want of you?

A. Well, I don't know, unless it was to read the specification, as that is all I did that I recollect of now.

208 x-Q. Did he not ask your advice as to the arrangements he was entering into with regard to the application?

4336 A. I don't recollect that he did; the arrangements were all made.

281 x-Q. Did he not tell you what those arrangements were?

A. He did not surely until after the transaction was closed.

282 x-Q. You know that there was something unusual in the matter, that is, that it was not to be simply

4337 for the benefit of your client, the Electro Dynamic Light Co., which controlled the inventions of Sawyer and Man?

A. I did not know, nor did I hear a single thing about it until it was all done, or about to be done. The motive for the doing of it was entirely unknown to me, until I went with Mr. Man to Mr. Cheever's office to execute the papers.

283 x-Q. What was it that become known to you then? 4338

A. Well, nothing except that they were about to make an application for a patent, and that Mr. Sawyer had consented to join in the application; subsequently Mr. Man told me what the arrangement was.

284 x-Q. What was the arrangement?

A. He said that the Electro Dynamic Light Co. had made an arrangement to sell the invention of the patent in suit to Mr. Cheever, contingent upon Mr. Cheever's paying to the Electro-Dynamic Light Co., I think, a hundred thousand dollars for this invention, 4339 within a certain time, and failing to pay the money within the time agreed upon, all the rights agreed to be given to Mr. Cheever were to be reverted to the Electro Dynamic Light Co., I think that is a general statement in substance of what he told me; that in the meantime Mr. Cheever had stipulated that he was to employ his own counsel, and bear the expenses of obtaining the patent.

285 x-Q. Was Mr. Cheever also to bear the expenses of an expected interference? 4340

A. That I do not know anything about.

286 x-Q. Do you not know that it was expected that there would be an interference with Mr. Edison in the Patent Office?

A. No, I did not know that.

287 x-Q. Did you ever see the contract with Mr. Cheever?

4341 A. No, I don't recollect that I did.

288 x-Q. Have you any papers in your possession of the Electro Dynamic Light Co, such as contracts, minutes of meetings of directors or officers of the company, &c.?

A. No, I have not.

289 x-Q. What is the character of the papers of the Electro Dynamic Light Co., that you have in your possession, if any?

A. I have the assignments to the Electro Dynamic
4342 Light Co. of Sawyer and Man. I think the whole of them have been put in evidence in one case or another.

290 x-Q. Have you at any time had other papers of that company in your possession. If so, what has become of them?

A. Yes, I have had papers of the company in my possession, a good many papers. Some of which belong to the company, and some of which belong to Mr. Jacob Hays, for whom I took out the foreign patents, but I returned them all to Jacob Hays, who
4343 was an officer of the company, and at that time, as I understood it, had possession of the papers.

291 x-Q. Who is the Mr. Cheever you have spoken of?

A. I refer to Mr. Charles A. Cheever, of New York City.

292 x-Q. Who was his attorney on the application?

A. As I understand it, Mr. William D. Baldwin, of Washington.

293 x-Q. He prepared and filed the applicaiion for
4344 the patent in suit, did he not?

A. It appears so by the record, of my knowledge I don't know, I did not see him prepare it or file it.

294 x-Q. It appears that an interference was declared with an application of Edison, September 25, 1880, and that on December 4, 1880, you were ap-

pointed attorney in the application for the patent in 4345
suit all former powers of attorney being revoked. Please state the circumstances under which you were appointed attorney in this case.

Objected to as not cross-examination, also because it does not appear from this record that Edison filed any application, nor do any of the other facts stated in the question appear from the record. If any other record
is referred to, such record is the best evidence 4346
of the facts stated, and should be offered in evidence, if the counsel desires such facts to appear.

Counsel for defendant states that the record referred to by him in his question, is the file wrapper and contents in the application for the patent in suit.

A. Albon Man came to my office, and as Vice-Presi- 4347
dent of the Electro Dynamic Light Co., said to me that Mr. Cheever had failed to keep his agreement with the company; that is to say, he had not paid the money agreed upon, and that all the rights of the company to the invention in question had again reverted to it, and that the company desired that I should appear for it and prosecute the application, and thereupon a power of attorney was given to me, or sent to me, I don't remember which, to take charge of the case. All the rest
appears in the record. 4348

295 x-Q. Did you draw the power of attorney itself, and secure its signature by Thomas Wallace, President of the Electro Dynamic Light Co?

Same objection.

A. I really don't recollect whether I wrote it and sent it down to the office for execution, or whether it

4349 was sent to me. I know I had a power of attorney, and I know I filed it, and that thereafter I appeared in the case to the close thereof.

296 x-Q. Who are F. L. Gaylord and W. G. Benham, if you know?

Same objection.

A. Now, that you have called my attention to that, my impression is that they were men in the employ of
4350 Wallace & Sons, at Ansonia, and that the power was sent up there for Tom Wallace to sign.

297 x-Q. What was said at the interview which you had with Mr. Man at his office, after seeing the Herald article, which has been put in evidence in this case?

A. Without undertaking to repeat the words which were used by Man and I in our conversation on that occasion, I asked Man if he had read the article in the Herald referred to, and he replied in the affirmative. I asked him if he could not get Sawyer then to join in an
4351 application for the patent, to which he replied that he was engaged in some negotiations by which he hoped to be able to bring it about. I don't recollect that there was anything further said. He was very busy with a lot of men about some real estate matters for some of the Lorillards, and, as he did not seem to have anything further to say to me, I turned and left the office.

298 x-Q. That was the entire conversation, or substantially all of it?

4352 A. Certainly; there was nothing more said that I remember of.

299 x-Q. After the interference between Sawyer and Man had been decided, and the application for the patent in suit was returned to the Primary Examiner for action on the merits of the invention, what then happened in the prosecution of the application?

4353

Objected to as not cross-examination and incompetent, the record of the proceedings in the application in the Patent Office being the best evidence.

A. Well, I went on and prosecuted the application until I got the patent. The several steps taken by me in that prosecution, I do not now remember, but they are all matters of record, and can be proved by the record. 4354

300 x-Q. You recollect very distinctly that an interference was declared with an application for a patent upon the same invention of Walter K. Freeman?

Same objection.

A. There was an interference declared with some man by the name of Freeman. I don't recollect his initials.

301 x-Q. Did it come to your notice what electric light interest was represented by the Freeman application? 4355

A. Yes.

302 x-Q. What was it?

A. I think that this man Freeman was assignor to the United States Electric Lighting Company, but that is only as I understood it. I don't recollect of ever seeing the assignment.

303 x-Q. What made you think it was the U. S. Electric Lighting Company?

A. Because I think Mr. Parker W. Page appeared as solicitor for Freeman, and he was solicitor for the U. S. Electric Lighting Company, and I know that he and Mr. Marcellus Bailey, of Washington, were associated as solicitors for the U. S. Electric Lighting Company. 4356

4357

304 x-Q. And both Page and Bailey represented the Freeman application?

Last objection continued.

A. That is the way I understood it.

Adjourned till Friday, the 18th inst., at 10 A. M.

FRIDAY, January 18, 1889.

4358 Met pursuant to adjournment.

Present—Counsel as before, and the cross-examination of Mr. Broadnax continued as follows:

305 x-Q. What became of this interference with Freeman?

Same objections.

A. The interference, as I recollect it now, was al-
4359 lowed to go by default on behalf of Freeman. At all events, it was not prosecuted on his behalf.

306 x-Q. Why was it not prosecuted on his behalf?

Objected to as not cross-examination, and immaterial and incompetent.

A. As I recollect it now, the U. S. Electric Lighting Company, as I understood it, was the owner of the invention claimed to have been made by Freeman, and that company proposed to submit the question of pri-
4360 ority of invention to arbitration, and in the event, that the arbitrators decided that Freeman was the first inventor, that the patent should issue to Freeman, instead to the assignees of Sawyer and Man for such parts of the invention as Freeman claimed. The question of priority was submitted to arbitration, and priority was awarded to Sawyer and Man, and thereupon

4361

the application of Freeman was abandoned, and a patent issued to Sawyer and Man or their assignees.

307 x-Q. What benefit did the U. S. Electric Lighting Company get from the arrangement?

Same objections.

A. That I do not know.

308 x-Q. How did the proposed arrangement first come to your attention, and who brought it to your attention?

Same objections. 4362

A. I really do not remember whether the matter was first brought to my attention by Mr. Curtis, one of the attorneys of the Electric Light Co., or by Mr. Garden, the then Vice-President of the Consolidated Electric Light Co., but it was from one of them that I first heard of the proposal to arbitrate.

309 x-Q. What was the proposal in detail that you then heard? 4363

Same objection, and this objection is continued to all questions that may be asked in regard to the so-called Freeman interference, and any proceedings connected therewith.

A. As I recollect it, the purpose on the part of the Consolidated Electric Light Co., was to avoid being tied up in the Patent Office in another interference. That was the moving cause, I think, on behalf of the 4364
Consolidated Electric Light Co., and the moving cause on behalf of the U. S. Electric Light Co. for getting that application filed and entering upon the arbitration, was to get a license under the patent that had been allowed to us for the invention. So the two companies agreed to submit the matter to arbitration, and that the

4365 party in whose favor priority of invention was awarded, should grant the other party a license under the patent on some terms which had been p eviously agreed upon.

310 x-Q. Did you have anything to do with the drawing of the agreement ?

A. Yes, I think I did, that is, the agreement for arbitration, I don't recollect whether I drew the license or not.

4366 311 x-Q. You drew the agreement to arbitrate then ?

A. I don't recollect whether I did or not. I have an impression that Mr. Curtis made the first draft, or somebody in the interest of the U.S. Electric Lighting Co., and that I revised it. And then, I think, it was still further revised by Mr. Garden or Mr. Curtis, or somebody, perhaps Gen. Duncan.

312 x-Q. Was it submitted to you before execution.

4367 A. I do not recollect whether it was or not, but I should take it for granted that it was.

313 x-Q. Was it submitted to you after execution for approval as to its manner of execution ?

A. No, I don't remember to have seen it at all after its execution.

314 x-Q. It was, however, an agreement between the complainant herein and the U. S. Electric Lighting Co. owning the invention of Freeman, and relating to the disposition of the interference between the Free-
4368 man application and the application for the patent in suit ?

A. Yes.

315 x-Q. About when was it executed ?

A. I don't know.

316 x-Q. When did you do your work upon it ?

A. I don't recollect even that. It was sometime, I

— 4369

think, in 1885. It was somewhere between the time of the declaration of the interference of Freeman and the decision of that interference in favor of Sawyer and Man.

317 x-Q. Did you not talk with more than one person about the matter of this agreement ?

A. I don't recollect of having any talk with any one about it, excepting Mr. Garden and Mr. Curtis.

318 x-Q. As the attorney for Sawyer and Man in the
application, you received a notice from the Patent Of- 4370
fice that the interference with Freeman had been declared, did you not ?

A. I did.

319 x-Q. Did you know before that time, or had it been intimated to you, that there would be such an interference ?

A. No, I never heard of this Freeman till I got notice of the interference from the Patent Office. After I got through with the prosecution of the application
of Sawyer and Man, that is, after all the claims had 4371
been allowed by the Examiner, he told me that he could not issue or send out the formal notice of allowance for the reason that there was an application pending by some one, he didn't say who, that might be put in interference with us, and a short time after that I got the notice of interference, and knew then for the first time who the applicant was and his assignee.

320 x-Q. After receiving the notice of interference, did you inform your client, the complainant ?

A. I think I sent the notice to Mr. Garden. 4372

321 x-Q. With a letter ?

A. Well, I don't know.

322 x-Q. Your recollection is, however, that you did not take it to him personally, and discuss it at that time ?

A. No, I have no such recollection, because, in fact,

4373 I don't recollect whether I sent it to him, or went with it to him. He may have been in my office and I handed it to him there, or I may have taken it to him at his office, or I may have sent it by letter, I don't recollect as to that.

323 x-Q. Will you look at your letter book and see if you sent it by letter?

A. Upon an examination of my letter book, covering the whole of March, 1885, I do not find that I sent
4374 any letter to Mr. Garden during that period that bears in any way upon this subject matter, and it is not at all likely that I would have written him a letter upon that subject, as we had personal intercourse almost every day.

324 x-Q. Were you in Washington or New York, when the interference was declared?

A. I was in New York, to the best of my recollection?

325 x-Q. But you do not recollect the circumstances
4375 or occasion of handing or sending the interference notice to Mr. Garden?

A. I do not.

326 x-Q. Do you recollect the first conversation you had with Mr. Garden with regard to this interference with Freeman?

A. No, I do not.

327 x-Q. Did you not tell him during some conversation that the interference with Freeman would delay the issue of the patent to Sawyer and Man?

4376 A. I have no recollection of having done so, nor can I see why I should, as he knew that of his own knowledge.

328 x-Q. Do you recollect any conversation that you had with Mr. Garden on the subject of this interference?

A. I doubtless talked with him, and he with me on

4377
the subject of this interference, but I have no particular interview in my mind that I can distinguish from any of the rest.

329 x-Q. Kindly tell me what you can recollect about these interviews, how many there were, when they took place, and what was said?

A. I cannot tell you how many there were, what was said at any of them, nor when they took place. Of course there was a good deal of talk between Garden
and I about it, and we agreed pretty generally that it 4378
was a put up job to wring a license out of us, and we discussed on various occasions the question of policy, as to whether it was best for us to submit to the extortion or to spend another year or two in interference in the Patent Office, and finally we reached the conclusion that it was best to submit.

330 x.Q. The result was that you and Mr. Garden concluded it would be better for the complainant to purchase the release from the annoyance, risk and de-
lay of another interference by giving the U. S. Electric 4379
Lighting Co., a license, which was done?

A. I don't think either of us had any doubt after the investigation of the matter, such as we were able to make, about our success in the interference, but the situation of our company at that time made it desirable for us to have the patent issue without further delay, and to avoid the delay which would inevitably occur in fighting the interference, we thought it best to succumb and give the U. S. Electric Lighting Co., a
license under the patent, which was done. 4380

331 x-Q. Do you recollect the terms of the license agreement?

A. I do not.

332 x-Q. Those terms, I suppose, were substantially stated in the agreement which you have called the agrement to arbitrate, and which you helped in the preparation of?

4381

A. I presume that they were.

333 x-Q. Did you not also draw the license agreement, or assist in drawing it, or have it submitted to you for approval?

A. I do not recollect whether I drew it or revised it, or whether it was submitted to me merely. The probabilities are that I drew it.

334 x-Q. By the agreement was the U. S. Electric Lighting Co. to pay royalty for the use of the invention of Sawyer and Man?

4382 A. Yes.

335 x-Q. A substantial or a merely nominal royalty?

A. I don't recollect the amount of the royalty. I think it was so much a lamp, but how much I don't now remember.

336 x-Q. Was any distinction made as to the character of the lamps that were to be included or excluded in the payments of royalty?

A. I don't recollect. All I recollect is that there
4383 was a license, and that they were to pay royalty, but how much royalty, and what the circumstances or conditions were, I don't recollect. In fact, it is impossible to swear to the contents of the paper, because I don't recollect it.

337 x-Q. Do you not recollect that lamps having carbons made from the material known as tamadine were, by the license agreement, not to be considered subject to the payment of royalty?

A. There is some provision in the paper about tam-
4384 adine, I think, but what it is, I don't know.

338 x-Q. Is it your recollection that the tamadine lamps were made subject to royalty?

A. No, I have no recollection about it.

339 x-Q. After the agreement which you have termed the agreement to abritrate was settled upon, please

4385

state what was actually done, and who did it, with regard to the arbitration?

A. I think I appeated at the arbitration as counsel for the Consolidated Electric Light Co., and I think Gen. Duncan appeared for the U. S. Electric Light Co. and Mr. Garden was arbitrator for our side, and Mr. Quimby was arbitrator for the U. S. Electric Light Co., and a third arbitrator was to be called in, in case they could not agree, and on behalf of the Consolidated Electric Light Co., the records of the interference
between Sawyer and Man on the one side, and Thomas 4386
A. Edison on the other, about the subject matter of the patent in suit, was submitted in support of our case, and the *ex parte* affidavits of Mr. Freeman and others taken in support of Mr. Freeman's claim, were submitted in support of Mr. Freeman's case, and thereupon the matter being duly argued by counsel, and considered by the arbitrators, they unanimously decided that Sawyer and Man were the first inventors.

340 x-Q. It did not become necessary then to call 4387
in the third arbitrator?

A. No.

341 x-Q. When did this take place, where, who were present, and how long did it last?

A. The arbitrators met in the office of Mr. Curtis, Mr. Leonard E. Curtis, one of the attorneys for the U. S. Electric Lighting Co. He was present, Mr. Duncan was present, Mr. Garden was present, Mr. Edward E. Quimby, the gentleman who appears as expert in patent causes, was present. I was present, and that is all
that were present. We were together there probably 4388
the best part of an hour, in presenting the case, and I don't know, I think it was two or three days before the arbitrators made their report I think they made their report in writing. This meeting was before the decision in the interference was made in the Patent

4389 Office, I think, but I cannot give the date, because I don't recollect it.

342 x-Q. Do you recollect that it was some time after the interference with Freeman was declared, and before the decision of that interference by the Patent Office?

A. Yes; I should think so.

343 x-Q. To whom was the report of the arbitrators made?

4390 A. I suppose that it was made to the U. S. Electric Lighting Co., and to the Consolidated Electric Light Co., but I don't remember to have ever seen it.

344 x-Q. You were told the conclusion of the report, I suppose, by somebody?

A. Yes, undoubtedly. I think when the hearing was over Mr. Garden said that he was willing to leave the decision to Mr. Quimby, and after Mr. Quimby decided in favor of Sawyer and Man, Mr. Garden merely concurred.

4391 345 x-Q. What became of the record and affidavit submitted to the arbitrators?

A. The record submitted upon our part was the same printed copies that were used before the Commissioner of Patents on the final hearing of the interference with Edison, and those were afterwards returned to me. What was done with the affidavits submitted on behalf of the U. S. Electric Lighting Co. I do not know.

346 x-Q. After the interference with Freeman was

4392 disposed of you continued the prosecution of the application of Sawyer and Man in the Patent Office, did you not?

A. I do not recollect whether I did anything further or not after that, but I presume I followed it up until I got the patent. The record will, of course, show what I did, but I do not recollect it of my own memory.

4393

347 x-Q. Did you not consult with the attorneys for the U. S. Electric Lighting Co. as to the form which the application should be finally given before the patent should be issued?

A. No, sir; I did not. I recollect going to Mr. Curtis for some information about some patent, but what it was now I do not recollect.

348 x-Q. Who suggested the amendments in the paper filed by you in the application, April 21, 1885.

A. I did and wrote it, and it is now as I wrote it. 4394

Counsel for defendant requests counsel for complainant to produce the two agreements between the complainant and the U. S. Electric Lighting Company, relating to the invention of the patent in suit, and described by the witness as an agreement to arbitrate the interference between Sawyer and Man and Freeman, and the license agreement under the patent in suit, also, the report of the arbitrators based upon the agreement to arbitrate. 4395

AMOS BROADNAX.

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4397

NEW YORK, January 25, 1890.

Met pursuant to adjournment.

Present—Counsel as before.

THOMAS B. STILLMAN, a witness produced on behalf of defendant, being duly sworn, and interrogated by Mr. Broadnax, testifies as follows:

1 Q. What is your name, age, residence and occupation?

4398 A. Thomas B. Stillman; 37 years of age; Professor of Analytical Chemistry, Stevens Institute, Hoboken.

2 Q. Are you the same Thomas B. Stillman that testified in the case of the Consolidated Electric Light Company vs. The McKeesport Light Company in a case pending between these parties in the Western District of Pennsylvania?

A. I am.

3 Q. And is your testimony to be found between pages 1,004 and 1,031, inclusive, and also between
4399 pages 1,424 and 1,432, inclusive, of Volume II, of the printed record in that case?

A. Yes, sir.

4 Q. Referring now to the carbon illuminants used in the Sawyer-Man lamps referred to in the depositions to which I referred in my last question, please examine the carbons now shown you, being the carbons produced by Mr. Knowles yesterday and put in evidence, and state, if you please, how those carbons compare in size—I mean in diameter—with the diameter
4400 of the carbons used in the lamps referred to in your depositions, to which I have referred?

A. The straight pencil carbons in use in the lamps which I filled varied in thickness, some being quite small and others relatively large; these being about the smallest size for use in the lamps with a straight pencil.

5 Q. That were used in the lamps having the straight pencil and which you charged? 4401

A. Yes, sir.

Cross-examination by MR. SEWARD.

6 x-Q. In what year did you see the carbons referred to in your preceding answers?

A. The year in which the Sawyer-Man people were at 94 Walker street; in December, 1878. I could not state positively without looking at my papers. 4402

7 x-Q. And is your statement this morning as to the size of the carbons shown to you, as compared with those in use in that month, in that year, and in that place, your best memory upon that subject?

A. In no one month were the carbons of the same size. Experiments were constantly being made as to the shape of the carbons, and the size of the carbons. I filling lamps containing carbons of small diameter, and others, in which the diameter would probably be three times the size of the diameter of the samples just 4403
submitted.

8 x-Q. Do you know of what the samples submitted are made, or how they were made, or when, where and by whom they were made?

A. The carbons generally in use then were the Carré carbons, but others were being used at the same time made of other material.

9 x-Q. Do you know whether the samples produced are or are not the Carré carbons? 4404

A. I do not.

It is agreed that the depositions of Thomas B. Stillman and of the preceding witness, Edward R. Knowles, may be used without the signature thereto of the respective deponents.

Counsel for the respective parties stipulate that the depositions referred to by complainant's counsel upon

4405 his examination in chief of this witness Thomas B. Stillman, be printed and used herein with like effect as if taken in this case.

Deposition of Thomas B. Stillman in McKeesport Case.

New York, March 30, 1889.

4406 Present: Thomas B. Kerr, counsel for complainant; and Richard N. Dyer and Walter K. Griffin, of counsel for defendant.

Thomas B. Stillman, a witness on the part of the complainant, being duly sworn, deposes as follows in answer to interrogatories by Mr. Kerr:

1 Q. Please to state your name, age, residence and occupation?

A. Thomas B. Stillman; age, 37; residence, Hoboken, New Jersey; my profession, analytical chemist.

4417 2 Q. Were you acquainted with William E. Sawyer; and if so, when did you get to know him?

A. Yes, sir; in December, 1878.

3 Q. Are you acquainted with Albon Man? If so when did you get to know him?

A. Yes, sir; at the time that I became acquainted with Mr. Sawyer.

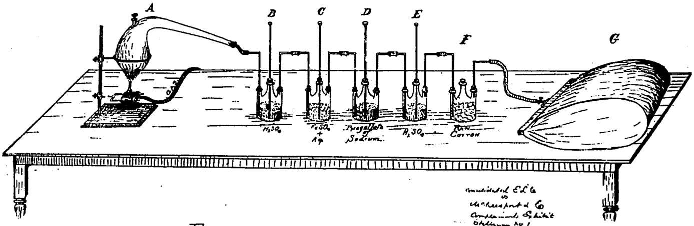
4 Q. Under what circumstances did you become acquainted with Sawyer and Man?

A. I was consulted by them at that time in regard to
4408 the preparation of pure nitrogen gas.

5 Q. For what purpose?

A. The gas to be used in the filling of the Sawyer and Man electric lamps.

6 Q. Did you do any work for them at that time; and if so, what?



PREPARATION OF NITROGEN GAS.

$NH_4Cl + KNO_2 = KCl + 2H_2O + N_2$

Consolidated E. L. Co
vs
McKeesport L. Co
Complainant's Exhibit
Stillman No 1
W. J. S. Seaman
March 30 1897

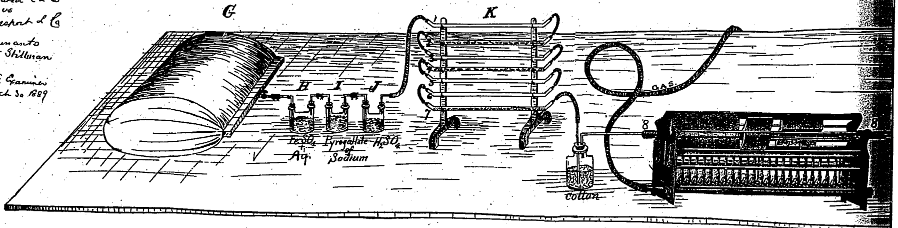
1 H_2SO_4
2 KHO
3 $FeSO_4$
4 KHO
5 $FeSO_4$
6 H_2SO_4
7 P_2O_5
8 Iron tube containing melted metallic Sodium
9 P_2O_5

STILLMAN No. 2.

PURIFICATION OF NITROGEN GAS.

Consolidated E L Co
vs
McKeesport L Co

Complainants
Exhibit Stillman
No 2
W. J. T. Examiner
March 30 1889



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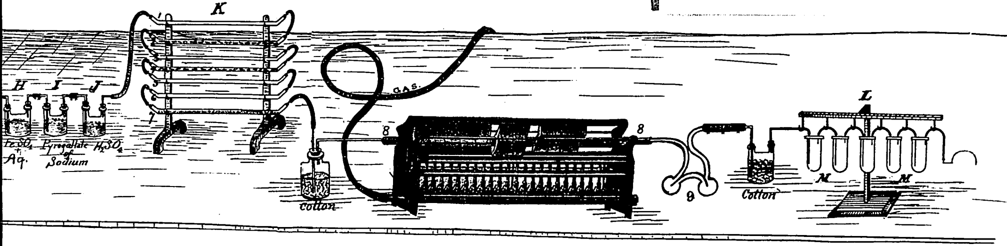
PURIFICATION OF NITROGEN GAS.



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A. I did. I arranged an apparatus for manufacturing and purifying nitrogen gas, and also filling the lamps with the same. 4409

7 Q. Where did you arrange this apparatus?

A. In the first place at 94 Walker street at their factory; and in the second place at my laboratory at 40 Broadway.

8 Q. Did they have any apparatus for that purpose at 94 Walker street before you arranged the apparatus you have spoken of for them? 4410

A. They did.

9 Q. Please describe it?

A. It consisted of a large glass retort connected to a series of Wolff bottles. The Wolff bottles contained purifying agents, and a large rubber bag as a receiver.

10 Q. Will you please produce drawing of the apparatus for purifying nitrogen gas and for filling the lamps, which was arranged by you for them?

A. I now produce the drawings required, which I have marked "Stillman No. 1" and "Stillman No. 2," 4411
drawing No. 1 representing the method of preparation of the gas, and drawing No. 2 the method of purification of the gas.

> The drawings produced by the witness are offered in evidence as Complainant's Exhibits Stillman No. 1 and Stillman No. 2. W. T. F., Examiner. March 30, 1889.

11 Q. Please describe the apparatus shown in the drawing "Stillman No. 1." 4412

A. It consists essentially of a retort marked "A," in which is placed a mixture of chloride of ammonium and nitrate of potassium, which, upon the application of heat and a sufficient quantity of water, generate nitrogen gas. This gas is then passed through a Wolff botte marked "B," containing some oil of vitriol

4413 as a dryer, then through the Wolff bottle marked "C," containing solution of sulphate of iron, then through the Wolff bottle marked "D," containing a solution of pyrogallate of sodium; then through the Wolff bottle marked "E," containing sulphuric acid; then through the Wolff bottle "F," containing raw cotton; thence to the receiving gas bag marked "G."

12 Q. Please describe the apparatus shown in the drawing Stillman No. 2?

4414 A. The gas bag full of the gas is put in connection with the following system of purifiers: first through Wolff bottle "H," containing solution of sulphate of iron; thence through a Wolff bottle marked "I," containing solution of pyrogallic of sodium; thence through the Wolff bottle marked "J," containing oil of vitriol in a series of long glass tubes marked 1 to 7 respectively, and shown in the drawing as "K" Tube No. 1, contains oil of vitriol; tube No. 2, broken pieces of caustic potash; tube No. 3, solution of sulphate of
4415 iron; tube No. 4, sticks of caustic potash; tube No. 5, solution of sulphate of iron; tube No. 6, oil of vitriol; tube No. 7, containing phosphoric anhydride; thence into a wash bottle containing cotton; thence into an iron tube containing metallic sodium, the metallic sodium being kept melted by means of a Bunsen combustible burner, through which the tube passes; this tube is marked No. 8 in the drawing. From thence the gas passes through two bulbs containing phosphoric anhydride; thence into a Wolff bottle filled
4416 with cotton, and thence to the lamps.

13 Q. Did you make any use of this apparatus at 94 Walker street?

A. I did. For preparing nitrogen gas to be used in the Sawyer-Man electric lamps, and I filled the lamps by the process and the apparatus just described.

14 Q. Please describe those lamps which were filled by you?

A. These lamps were the lamps being made by the Sawyer-Man people at 94 Walker street. They were all incandescent electric lamps, the light being given by a small piece of incandescent carbon in each instance. The carbons used were of various forms and material. There was the straight willow carbon, treated and untreated. There was the straight Carré carbon. There was the horseshoe paper carbon, treated and untreated; also the willow carbon, hollow and treated. 4417
Various names were given in the shop to these differ- 4418
ent forms of carbon. For instance, we had the straight pencil carbon which was called the hammer and anvil. There was the plain arch and the straight willow. Those were the three principal ones made at the time I was at the factory. The lamp consisted essentially of two metallic electrodes of various forms, but usually of two pieces of brass conductors passing through the base of the lamp, one to about three-quarters of the distance up, the other parallel to it, and extending
some distance further up the globe. The ends of the 4419
brass rods or tubes were connected to large pieces of carbon which acted as the receiver for the pencils of carbon used as an illuminant. Various devices were made use of to maintain the contact of these larger pieces of carbon perfect with the carbon used as the illuminant. In the straight pencil lamp a long and delicate spring extending from the upper portion of the brass conductor connected with the upper end of the pencil, extended to the base of the lamp, retaining the
pressure of the carbon uniform when in a heated con- 4420
dition. In the arch lamp, however, no use was made of the spring for this purpose, as it was found by experiment that the passage of the current through the carbon arch did not rupture the carbon, and that the arch itself relieved the carbon of the strain. In filling the lamps with nitrogen gas, the gas was passed through a tube to the upper end of the globe, and the air displaced by the nitrogen passing out through an

4421

aperture at the base in the other side. When the air had been displaced a current of electricity was turned into the lamp and the carbon maintained in a state of incandescence from one-half hour to an hour, to drive out any occluded gases that might be present. The filling tube was then withdrawn, valves turned, and the lamps closed. Lamps standing this test were passed by me and sent to the factory or office for exhibition. The base of the lamp consisted of two glass plates attached to the end of the globe by means of
4422 screws running up through the plates. The plates were joined together by means of Canada balsam, when the lamps were filled; sealing-wax was then placed around the base, securing the interior of the globe from admixture with the air from the outside. A short time after my working in the factory at 94 Walker street, I ordered a sealing mixture for the base of the lamp, as the wax at times became soft. To overcome this, a mixture containing caoutchouc was used, which when cold adhered firmly to the glass and made a tight
4423 joint. The globe of the lamp was a long cylindrical one about two inches in diameter and from six to ten inches in length.

15 Q. About how many lamps did you fill at 94 Walker street?

A. Forty or fifty lamps.

16 Q. Can you tell what proportion of these had arch shaped paper carbons?

A. I should judge about a third.

17 Q. You spoke about putting up a purifying and
4424 filling apparatus at your laboratory No. 40 Broadway. Please state when you did this and why?

A. The latter part of December, '78 or first of January, '79, I transferred the apparatus from the Walker street shop to my laboratory at 40 Broadway, as I could not devote all my time at the factory.

18 Q. Did you fill any lamps at No. 40 Broadway for

Sawyer and Man? 4425

A. I did.

19 Q. About how many?

A. There were a good many lamps. I couldn't tell you how many; over a hundred to a hundred and fifty.

20 Q. What was the character of the carbons in these lamps?

A. The same as I have previously described—straight pencil carbons and arch carbons

21 Q. What was the material of the arch carbon? 4426

A. Paper carbon.

22 Q. About what proportion of the lamps which you filled at 40 Broadway were provided with arch-shaped paper carbons?

A. I think the proportion was smaller than that at the Walker street shop, probably a quarter instead of a third.

23 Q. Was there any test applied to the lamps you filled at 40 Broadway?

A. Each lamp was subjected to the current of elec- 4427
tricity and the carbon kept incandescent from one half hour to an hour. No further test was made at my laboratory, but if the lamps maintained this incandescence without break or change in the carbon the lamps were returned to the factory as properly charged.

Adjourned until 2 P. M.

Met pursuant to adjournment. 4428

24 x-Q. Have you any record of any tests made with those lamps at 40 Broadway, and if so, please produce it and explain it?

A. I have, and now produce a record of some lamps tested January, 1879. This record shows the test made

4429 of some lamps sent to my laboratory from the Walker street factory to be charged with nitrogen gas. The first date is January 6th, 1879, on which date three lamps were sent down to be filled by me, one being a hammer and anvil specially prepared or treated, and one arch lamp, the latter being a paper carbon. The entry of January 6th contains the following remarks:

> "The hammer and anvil specially prepared —poor contact. The hammer and anvil plain
> 4430 —good fair carbon, but the hammer and anvil carbons appear short and poor. The arch in fair condition, but not very secure. It gives a light of about four candles with ten Ladd cells. If contacts are properly secured it will doubtless be the most economical and rational form yet devised."

This entry was made in the handwriting of my partner, Mr. William H. Fuller. January 8th is a record
4431 of one lamp marked "large willow carbon" with no remarks. January 9th three lamps were sent down, as follows: No. 1, anvil; No. 2, Crescent; No. 3, straight carbon. Under the head of remarks, No. 1, anvil, and No. 2, Crescent, both good. That is to say, they stood the test required by me, and were returned to the shop as satisfactory. No. 3, straight carbon, burned eighs minutes. On January 10th one lamp was sent down marked "willow carbon, large." The remarks under this show that it burned eight minutes. On January
4432 12th three lamps were sent down for me to fill, No. 1 being an arch lamp, No. 2 hammer and anvil, and No. 3 willow carbon. Under head of remarks, "Arch lamp formed arc in current of battery." No. 2, treated wood carbon, hammer and anvil, stood the test fifteen minutes; marked "Good fifteen minutes." No. 3, wilow carbon, "Not good, four minutes." On the 13th of

Date	Number of lamps filled	Kind of lamps	Remarks
Jan'y 6th	3	1 H.A. plain 1 H.A. sp. 1 arc.	H.A. ~~Sp.~~ poor contact (X) H.A. plain good fair carbon but the anvil & hammer carbons appear short and poor. The arc in fair condition but contacts not secure. The arc gives a light of about 4 candles with 10 Daniell cells. If properly secured it will doubtless be the more economical and rational form yet devised.
Jan 8th	1	large willow carbon.	
" 9th	2	(1) (2)	No 1, anvil, No 2 crescent, both good. No 3 burned 8 minutes.
" 10th	1	Willow c. large	– burned 8 minutes.
" 12	3	2	No 1, arch leaf formed arc in current of battery.
" ~~13~~	~~4~~		No 2 twisted wood c. good 15 m.
			" 3 W.C. not " 4 "
" 13	4		Of the lamps (7) sent up Jan 12 & 13 – 4 burned good.
" 14	3		
" 16th	4	Filled at	

Complainant's Exhibit Stillman record of lamp tests. W.P.F. Examiner. March 30, 1889

Cons E L Co {
McKeesport Co }

4433

January four lamps were sent up. On the 14th, three lamps. On the 16th, four lamps. Under remarks it states "Of the lamps (7) sent up January 12th and 13th four burned good.

> Paper offered in evidence as Complainant's exhibit Stillman Record of Lamp Tests. W. T. F., Examiner. March 30th, 1889.

25 x-Q. You state that the entry of January 6th, 1879, on this exhibit, is in the handwriting of your partner Mr. Fuller. Is he still your partner? 4434

A. He is not We dissolved partnership in 1880.

26 x-Q. Do you know where he is now?

A. No, I do not.

27 x-Q. In whose handwriting are the other entries on this exhibit?

A. In my own handwriting.

28 x-Q. When were they made?

A. At the dates set forth on the exhibit.

29 x-Q. Where has that exhibit been since 1879? 4435

A. In my desk at my office, 40 Broadway.

30 x-Q. Does this record show all the lamps which were filled and tested by you at 40 Broadway?

A. No, sir.

31 x-Q. Have you any other record showing the tests of the other lamps?

A. Not that I know of. I have looked but could not succeed in finding any.

32 x-Q. Was it your custom to keep a record of all the tests you made of those lamps? 4436

A. It was not.

33 x-Q. How did this record happen to be made?

A. It was started by Mr. Fuller, and I carried it along for a few days, later the lamps came more at a time and I had not the time to devote to it, and another reason was that no check record was kept at the factory of the lamps that I checked off at the laboratory.

4437
34 Q. Did you ever see any of these arch-shaped paper carbon lamps in use at 94 Walker street?

A. Yes, sir.

35 Q. Please state how they burned?

A. Some burned well and some poorly.

36 Q. Do you know what was the cause of the difference in the operation of those lamps?

A. My impression is that it was a mere mechanical difficulty, a failure to make proper contact between the carbon. Some lamps sent down to be filled, plainly
4438 showed this, as the record in the last exhibit also shows.

Adjourned until Monday, April 1st, 1889, at 11 A. M.

New York, April 1st, 11 A. M.

Met pursuant to adjournment.

Present—Thomas B. Kerr, of Counsel for complainant, and Walter K. Griffin, of Counsel for defendant.

4439 37 Q. What does the part marked "L" in the drawing Stillman No. 2, indicate?

A. It indicates the rack for holding the lamps during filling, the lamps being indicated in position by the letter "M."

38 Q. Was there any other apparatus used in filling the lamps which is not shown in the drawing Stillman No. 2?

A. There was. It consisted of dryers and a large aspirator, the dryers being used to prevent any con-
4440 tamination of moisture, and so forth, from the air, which might possibly come from this end of the apparatus, and a stop-cock to shut off the apparatus when completed.

39 Q. Will you please make a drawing illustrating this additional apparatus and produce it at the meeting to-morrow morning?

4441

A. I will.

40 Q. Please state whether you made any exhaustion of the lamp globes.

A. Yes, sir, I did.

41 Q. Please describe the apparatus you used for that purpose.

A. It was a simple water exhaust at use at 94 Walker street. A large number of the lamps were exhausted there and sent to me in an exhausted condition
at 40 Broadway. I also exhausted some in my labor- 4442
atory at the suggestion of Mr. Man, before charging the lamps with nitrogen. In my laboratory I made use of the mercury vacuum. In a few of the lamps the air was displaced by coal gas, and the coal gas displaced by nitrogen, and then the lamp sealed. The mercury vacuum consisted of a glass globe, two openings at the top, with stop-cocks, the lower portion of the globe being drawn down to a tube, in which tube was also a stop-cock. This globe was connected by rubber tubing
to a large bottle, similar in shape to a Wolff bottle, but 4443
having a stop-cock at its base. The method of using it was as follows: Mercury was placed in the glass bottle, the stop-cocks in the glass globe opened and the bottle containing the mercury placed upon a shelf some two or three feet above the heighth of the glass globe. When the mercury had filled the glass globe up to the stop-cocks they were closed, the stop-cock connecting with the apparatus was opened, the glass bottle removed from the shelf to the floor, the stop-
cock at the base of the glass globe opened, allowing the 4444
mercury to descend from the glass globe to the bottle, thereby filling the glass globe full of air which was formerly in the apparatus—in the lamps to be charged. This operation was repeated until we were satisfied that the air had been taken out of the lamps.

42 Q. You have spoken of the conductors in the

4445 lamps as being of unequal length. Was that the case with all the lamps?

A. No, sir. I referred to the hammer and anvil lamps—straight carbon. In the arch lamp of paper carbon they were of the same height.

43 Q. You have given the size of lamps filled by you, were they all of the same size?

A. No, sir, they varied in length and breadth.

44 x-Q. In the first entry on complainant's exhibit
4446 Stillman record of lamp tests, namely that of January 6th, in the handwriting of Mr. Fuller, one of the lamps is referred to as an arc lamp. Was that what is commonly known as an arc lamp?

A. It is not. It refers to an incandescent arch lamp.

45 x-Q. Referring now to the filling tubes, did all these lamps have a long filling tube reaching to the top?

A. Some of the lamps required a tube to be placed
4447 in during the process of filling, while in others the metallic conductor reaching to the top of the lamp was hollow, and served the purpose of a filling tube.

46 x-Q. Have you any recollection of the life of any of the Sawyer-Man lamps filled by you?

A. I have. Several of the lamps burned finely for a number of days, while one in particular burned several weeks in the shop at Walker street, and was in good condition when broken accidentally by one of the workmen in hammering something on the wall.

4448 47 x-Q. Where was this lamp placed when in use?

A. Part of the time in the shop and part of the time in the office at 94 Walker street.

48 x-Q. In what part of the shop?

A. Over the workmen's bench.

49 x-Q. Please state what kind of a carbon that lamp had.

A. It was a straight treated carbon, and when the

lamp was broken the carbon appeared of a silvery white color without any apparent break to it. 4449

50 x-Q. What was the atmosphere in that lamp?

A. Nitrogen gas.

51 x-Q. What was its mechanical construction?

A. The construction was the same as the hammer and anvil lamps I have already described?

Adjourned to meet on Tuesday, April 2d, at 10 A. M.

NEW YORK, April 2d, 1889, 10 A. M. 4450

Met pursuant to adjournment. Present counsel as before.

The examination of Mr. Thomas B. Stillman was resumed.

52 x-Q. To what in your opinion was the durability of this particular lamp due?

Objected to as incompetent. 4451

A. To proper contact between the carbons, and proper filling with nitrogen gas.

53 x-Q. Do you remember anything about the subsequent history of that lamp?

A. Yes, sir. The same lamp was set up with the same carbon and filled with nitrogen gas and run for a few hours when an arc formed in the carbon, caused by poor contact, and the carbon was soon destroyed.

54 x-Q. You speak in question 46 of several of the lamps burning finely for a number of days. What 4452
kind of carbons did these lamps have?

A. They were all of the various forms of carbon sent down to the laboratory to be filled—straight pencil, arch paper carbon.

55 x-Q. How did you come to know about the lives of these lamps?

4453

A. By being in the shop off and on from day to-day, meeting people there who were interested in the lights, and who were carefully watching them and who were very much interested in the existence of the lamps.

56 x-Q. Was it any part of your business to take records of the lives of the lamps?

A. No, sir.

57 x-Q. Can you produce any letters from William E. Sawyer in regard to the filling of lamps, and if so, please produce the same?

4454 A. Yes, sir. I produce a letter written to me by Mr. Sawyer March 5th, 1879, regarding the filling of some lamps by me with nitrogen gas.

> The letter is offered in evidence as Complainant's Exhibit Sawyer-Stillman letter of March 5, 1879. W. T. F., Examiner.

58 Q. I notice that the year is not given on that letter. What makes you say it was written in 1879?

A. I identify it by means of the composition of the

4455 letter, and from the fact that at that time the base of some of the lamps was sealed up with sealing-wax.

59 Q. Where has that letter been ever since it was received by you?

A. In my office desk at 40 Broadway.

60 Q. Are you familiar with the handwriting of William E. Sawyer?

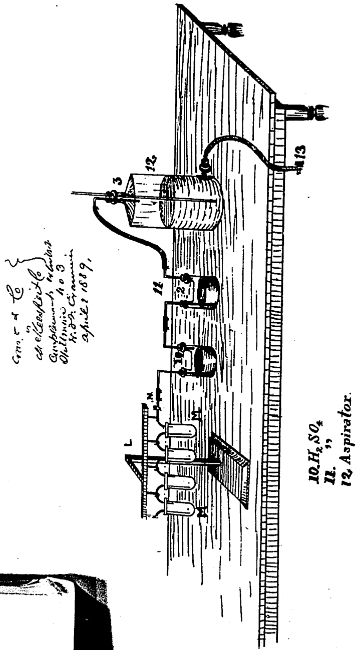
A. Yes, sir.

61 Q. Is this letter in William E. Sawyer's handwriting?

4456 A. Yes, sir; it is.

62 Q. In question 39, during yesterday's examination, I asked you to produce a drawing showing the additional apparatus used in filling the lamps. Have you made and will you now produce such drawing?

A. I have, and now produce it.



4457

The drawing is offered in evidence as Complainant's Exhibit Stillman No. 3. W. T. F., Examiner.

63 Q. Please describe the apparatus shown by the drawing and its operation?

A. The last lamp in the series marked "M" is connected with a straight glass tube containing the stop-cock "N." This tube is connected with another passing through a wash bottle containing sulphuric acid marked "10" in the drawing, then through another wash 4458
bottle containing sulphuric acid marked "11." This is connected with a large aspirator in which there is a safety glass tube passing through the liquid and out through the top of the aspirator. This safety tube indicating by the rise and fall of water in the tube the the pressure of the gas passing. The fall of the water from the aspirator is regulated by a stop-cock, marked "13." When the air is displaced out of the lamps by the nitrogen, the gas is shut off from the bag "G" and the water allowed to run from the aspirator 12 4459
until the safety valve in the aspirator shows a slight exhaust existing through the system. The stop-cock marked "N" is now turned off and the lamps sealed in the usual matter. The gas is shut off from the bag G by the stop-cock shown in the neck of the bag.

64 Q. What was the object of the slight exhaust you have spoken about in your last answer?

A. The object was to have the amount of gas in the globes that when the lamps were burning the gas being expanded by the heat generated by the incan- 4460
descent carbon would be under normal atmospheric pressure.

4461 *Cross-examination by* Walter K. Griffin, Esq., *Counsel for Defendant:*

65 x-Q. Up to what time did you continue to fill lamps for Mr. Sawyer?

A. Until the company moved to Ansonia, Connecticut.

66 x-Q. What was the date of this?

A. I think in the spring of 1879.

4462 67 x-Q. Have you any books or papers which enable you to fix the date?

A. No papers relating directly to the moving of the company to Ansonia, but I have one or two letters from Mr. Sawyer written from Ansonia to me in the summer of 1879 in regard to the use of bi-sulphide of carbon in prisms. He was then with Wallace & Co., of Ansonia, Conn.

68 x-Q. Were you acquainted with the lamp called by Mr. Sawyer the feeder lamp?

4463 Objected to as incompetent and irrelevant.

A. I was.

69 x-Q. Did you fill any of these feeder lamps for Mr. Sawyer?

A. My impression is I filled a few. These lamps were much larger than the Sawyer-Man lamp and were made at his factory on Fulton street, over McKeson & Robbin's drug store, City, Mr. Sawyer then acting for the Eastern Electric Manufacturing Co.

4464 70 x-Q. Have you any books or papers showing your charges for services rendered Messrs. Sawyer and Man during the period you have mentioned?

A. No, Sir.

71 x-Q. Did you ever have any?

A. In my partnership with Mr. Fuller at that time an account was kept of disbursements and receipts of matter belonging to firm work but not of indivinual

work, that is to say, our partnership was of such a nature that all work brought into the office from parties unknown to us was considered firm work; but through our friends, individual work. In this way I considered that the work brought to me by the Sawyer-Man people, through Mr. Edwin L. Myers, who was a former student of mine, belonged to me exclusively. I have no record, so far as I know, of the amounts paid me by Sawyer and Man, nor at the present moment have I any idea what it was. 4465 4466

72 x-Q. Will you please look and see if you can find any such record?

A. I will; but I can state in a general way that payments were made by check, and I think those amounts could be obtained from the treasurer of the company.

73 x-Q. When were you last at the shop 94 Walker street?

A. In the spring of 1879.

74 x-Q. How late in the spring?

A. My impression is that it was about April. 4467

75 x-Q. Do you remember seeing at any time at Walker street certain feeder lamps, that is to say, lamps in which a pencil of carbon was capable of being fed up so as to compensate for its destruction by the current?

A. No, sir; not at 94 Walker street.

76 x-Q. Have you no recollection of any such lamps at 94 Walker street?

A. No, sir.

77 x-Q. Have you no knowledge of their use there 4468 in any way?

A. No, sir.

78 x-Q. And never heard of their being used there?

A. No, sir.

79 x-Q. After the time you began to fill lamps at 40 Broadway how frequently were you at 49 Walker street?

4469

A. Quite frequently; that is to say, in one week I might be up there a dozen times, and another week three or four times.

80 x-Q. What would take you up there?

A. In some instances my desire to see how the lamps were progressing and burning, and in other cases Mr. Man or Mr. Sawyer would sometimes send for me.

81 x-Q. How long would you remain there?

A. Various lengths of time, from a few minutes to sometimes two or three hours.

4470 82 x-Q. How many times are you certain you remained there as long as two or three hours?

A. It is impossible to state positively. Probably fifteen times.

83 x-Q. Are you certain that you filled any lamps for Mr. Sawyer after March 20th, 1879? I meaneas to Walker street?

A. I am not positive in regard to that particular date. It was about that time, or a little later, my impression is, they moved to Ansonia.

4471 84 x-Q. In what condition were the lamps brought to you for filling at 40 Broadway?

A. All ready to set up in the circuit for filling with nitrogen gas. A few at times being exhausted at the Walker steet shop, and others not exhausted.

85 x-Q. By exhausted what do you mean?

A. The air being taken out from the lamps.

86 x-Q. Do I understand you that you would arrange these lamps on the stand L, in connection with your apparatus shown in your sketches, and fill them with

4472 nitrogen gas?

A. Yes, sir.

87 x-Q. And the general principle of your apparatus was by means of a suitable water suction to draw nitrogen gas through a series of tubes or bottles containing chemicals, thereby purifying the gas, or depriving it of moisture. Is that so?

4473

A. It is.

88 x-Q. You have mentioned that in certain lamps you had to insert tubes into the lamps for the purpose of filling the same with nitrogen gas in such manner that one of the tubes should extend to the upper end of the lamp globe while the other should be shorter, terminating near the base of the globe. Please state the object of this so that the Court may understand it?

A. The extension of the tube to the end of the lamp was for the purpose of allowing the nitrogen to more thoroughly permeate every part of the lamp while the 4474
latter was being filled.

89 x-Q. If the tubes had been short, terminating near the base of the lamp would it not have been almost impossible in tubes of the diameter and length you described as used for the lamps to have got rid of the air at the end furthest removed from the base?

A. I think not, but there would be a much longer time occupied in making this displacement.

90 x-Q. And with an ordinary aspirator such as you used very much longer time, would it not? 4475

A. The length of time is dependant upon the rapidity of the gas.

91 x-Q. Putting it in another way, the consumption of nitrogen gas in order to arrive at the filling of the globe with nitrogen would be very much greater with the short tubes would it not?

A. It would.

92 x-Q. In those lamps in which the metal conductors or radiators were tubular, I understood you to say that 4476
some provision was made so that the tubular conductor the acted, instead of the long tube you otherwise inserted in the lamp. What arrangement was made?

A. One of the conductors was hollow from the base to the top, passing through the bottom of the lamp and containing at its lower end a cock turned by means

4477

of a screw driver. Rubber tubing connecting the lamp with the system for purifying nitrogen gas was attached to the base of this tube and securely fastened, but not far enough up on the tube to cover the cock which was turned by the screw driver. By this arrangement the lamp could be securely shut off without being taken out of the system.

93 x-Q. And when this hollow conductor did not exist, how did you insert the long glass tube for the purpose of filling the globe with nitrogen gas?

4478 A. The metallic tube was passed up through the base of the lamp, fitting the tube in which the cock was placed loosely, the lower end of this tube passing into the rubber tubing, the rubber tubing itself being joined to the metallic tube which held the stop cock at the base of the lamp. When the lamps were filled with nitrogen this tube was withdrawn from the lamp, and allowed to pass down through the aperture at the base of the lamp into the rubber tube, and the instant it passed the stop cock, that was turned. The rubber
4479 tube was larger than the inner metal tube so that I could work the metal tube down into the rubber.

94 x-Q. What sort of a stop-cock was there to the base of the lamp?

A. It was a metallic cock; further than that I have forgotten the details of construction.

95 x-Q. How far were the lamps put together which you received at 40 Broadway?

A. The interior of the lamp was in complete order for running, so that no further change was necessary
4480 after the lamps were filled.

96 x-Q. Were the globes fastened to the base? If so, how?

A. The globes were fastened to the base first by having the surfaces of the glass plate evenly ground and Canada balsam placed between to fasten them together,

4481

and then long screws running from the upper flange of the base of the globe through to the lower glass plate and there secured.

97 x-Q. Were metal rings or flanges used above or below the base of the lamp?

A. I think there were—yes, sir.

98 x-Q. In other words the lamps were intended to be ready for filling. Is that so?

A. Yes, sir.

99 x-Q. And this was the case with all lamps sent to 4482
you at 40 Broadway. Was it not?

A. That was the condition of all lamps sent down to 40 Broadway to be filled. There were a few lamps sent down to me, however, to examine the carbons, generally by Mr. Man, who claimed that the lamps were not properly filled. That is to say, taking two lamps from one set which had been filled at the same time, two of any particular kind, as straight pencil or arch carbon, one lamp would burn well and the other poorly when tested with several hours run at the shop, and yet no 4483
apparent difference could have been noticed in those lamps when filled.

100 x-Q. In filling the lamps, did you ever open them, or were they kept closed?

A. They were always kept closed.

101 x-Q. After the lamps were filled by you, what did you do to them?

A. After turning the stop-cocks I soldered the stop-cocks, some of them with solder and some with sealing-wax, as required by Mr. Sawyer. 4484

102 x-Q. Did you put the lamps into their cups?

A. Not at 40 Broadway. I have no recollection of doing it.

103 x-Q. So that all you had was the globe, the base fastenings, and the interior works. Is that so?

A. In a few instances I sealed the lamps besides the

4485 stop-cocks by pouring a mixture of sealing-wax, caoutchouc round the base of the lamp, but did not set it in the metal cup.

104 x-Q. In test'ng the lamps, how many battery cells did you employ?

A. I had a large three-cell, bi-chromate dip battery, sufficient to bring each lamp in circuit to low incandescence.

105 x-Q. Was this bi-chromate battery what you
4486 have called a Ladd cell?

A. It is not. Mr. Fuller had a few Ladd cells there, which were used on a few of the lamps first sent down. But the battery did not work satisfactorily, being an old one, and I purchased us a new one.

106 x-Q. What degree of incandescence did you raise the lamps to?

A. Till the carbon became at a low red heat, not sufficient to give any light.

107 x-Q. Was this the case when you used the Ladd
4487 cells and the bi-chromate battery?

A. We had difficulty with the Ladd cells, and for that reason did not use them, except in the few instances stated.

108 x-Q. Do you mean that the Ladd cells were not so powerful as the bi-chromate battery?

A. No, I mean that at times the Ladd cells would operate and not operate, without apparent reason.

109 x-Q. When the lamps were filled and tested by you, what was done to them by you?

4488 A. They were laid carefully aside, and either sent up to the factory or they sent down for them; generally, however, they sent down for the lamps.

110 x-Q. Why were they laid carefully aside?

A. For the reason that they were made of glass, required careful handling.

111 x-Q. Except as you visited 94 Walker street,

had you any personal knowledge as to what was done to these lamps after they left your hands? 4489

A. No, sir.

112 x-Q. When a lamp or carbon proved defective under your test, what did you do, if anything, to it?

A. I returned it to the factory as unfit for trial at the factory.

Adjourned to meet on Wednesday, April 3d, at 10 o'clock A. M.

4490

New York, April 3d, 1889.

Met pursuant to adjournment.

Present—Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

113 x-Q. Am I right in understanding by your answer to question 41 that when you used the mercury tubes there mentioned, it was for the purpose of exhausting the air preparatory to filling the lamps 4491
with nitrogen?

A. Yes, sir.

114 x-Q. When you exhausted the lamps slightly so as to allow for the expansion of the gas when the carbon was rendered incandescent, did you have any uniform gauge or test, or did you make simply a slight exhaustion without definite accuracy?

A. The safety tube in the aspirator at the end of the apparatus I used as an indicator for a slight exhaust, the lowering or falling of the column of water in the tube indicating whether the gas was under pressure or 4492
under a slight exhaust. The meniscus of the water in the safety tube, which at normal pressure is slightly above the pressure in the aspirator, I would bring down to the level of the water in the aspirator.

115 x-Q. As I understand you, the exhaust was a very slight one, was it not?

4493

A. Yes, sir.

116 x-Q. In sending the lamps to 94 Walker street, did you put any tag or marks upon the lamps?

A. Only in the case of lamps which failed to stand the test of incandescence. I had no uniform tag; in some instances a note was sent describing the lamp which worked unsatisfactorily, the description in the note being sufficient to enable the parties at the factory to recognize the lamp spoken of.

4494 117 x-Q. When a carbon proved defective, what, to your knowledge, was the practice of the factory? Was the lamp thrown away, or the lamp taken apart and a new carbon substituted?

A. Generally speaking, the lamp was taken apart and a new carbon inserted. In some instances, however, some of the lamps were not set up again.

118 x-Q. When the carbon was replaced were the lamps refilled before being again used?

A. Yes, sir, the lamps were brought down to be
4495 filled under the same conditions as before, unless the carbon of a different form than the former one had been inserted.

119 x-Q. And if the carbon had been changed the lamp so changed was sent to be filled, was it not?

A. It was, and the lamp might be considered as an entirely new lamp so far as the carbon was concerned.

120 x-Q. What means, of your own knowledge, had you of knowing whether, for example, a lamp sent
4496 January 14 was the same or a different lamp from a similar appearing lamp sent, say, two weeks before?

A. In the case of lamps which I had filled and sent to the factory, and which ran there but a short time and then broke, it is probable my attention was not called to the matter, but whenever a lamp made an especially long run the lamp, after breaking, would be

4497

fitted with a similar carbon to the one which makes the long run, and in some instances a note to that effect from Mr. Sawyer would be sent to me.

121 x-Q. As I understand you, as a general rule, you did not then know whether the lamps sent to you for filling were the old lamps with new carbons or fresh lamps which had not been before filled?

A. In some instances where a carbon had been consumed at the factory in running the lamp an apparent change would take place in the appearance of the 4498
metallic conductor; that is to say, the upper portions of the conductors would have a different appearance in color than the lower portions.

122 x-Q. That is to say that in some instances the discoloration of the metal conductors showed to you that the lamp had been in use before?

A. Yes, sir.

123 x-Q. Where this discoloration did not exist, or where, for example, it may have been removed by cleaning the conductors, had you any means of identifying a 4499
particular lamp with a similar appearing lamp previously sent to you?

A. Two lamps of the same size, construction and appearance, would give me no indication to distinguish between a new lamp and an old one. That is to say, if the lamp which had been previously filled had been thoroughly cleaned and the wax or sealing material used at the base of the lamps entirely removed, there would be no distinction; but in nearly every instance, portions of the sealing material on the outside of the 4500
lamp would be left upon the base of the globe, these porportions being very small as a rule.

126 x-Q. And these remains of the sealing-wax existing, as you say, in nearly every instance enable you to say that the lamp had been used before. Is that so?

A. Yes, sir.

4501

127 x-Q. Do I understand you rightly that in nearly every instance the lamps sent to you showed such traces of sealing-wax?

A. Traces of sealing wax or of the other material they used for sealing the outside of the lamps.

127½ x-Q. Do you remember what your charge was for filling lamps at 40 Broadway?

A. No, sir, I do not.

128 x-Q. Do you think it was in the neighborhood of eighty cents per lamp?

4502 A. It would be impossible to answer that question, as I have no memoranda or recollection about it.

129 x-Q. You presented a record kept by Mr. Fuller and yourself of some twenty-two lamps. In your recollection is that record a fair illustration of your experience with the lamps you filled at 40 Broadway?

A. I do not think so for the reason that these were the lamps first filled at my laboratory, and later on with experience the work was more satisfactory.

130 x-Q. As I understand you, you had been filling
4503 lamps at 94 Walker street with the same apparatus you used at 40 Broadway?

A. Yes, practically the same apparatus. I took the apparatus down to 40 Broadway, but it was returned before the company went to Ansonia. I duplicated the apparatus at my laboratory.

131 x-Q. How did your apparatus differ from the apparatus at Walker street prior to the use of your method?

4504 A. The improvements that I made after going to the factory consisted in the use of phosphoric anhydride as a drying agent, and in the use of metallic sodium kept in a melted condition to absorb all traces of oxygen from the gas. I also inserted the drying tubes marked "K" in Stillman Exhibit No. 2.

132 x-Q. State what means were used prior to your method for preparing and purifying the gas?

4505

A. The method used was by heating a mixture of chloride of amonium and potassum nitrite withe sufficient water, and passing the volume of nitrogen gas through the system of purifiers marked Stillman No. 1. The reason that I introduced phosphoric anhydride was because I was under the impression that the gas made by the process described in Stillman No. 1 was not sufficiently free from moisture and air.

133 x-Q. Do I understand you that your figure 1 represents the entire apparatus used at Walker street before your improvement? 4506

A. Yes, sir.

134 x-Q. And the only substance in that apparatus tending to free the nitrogen from oxygen existing in the original air of the retort or entering by any leak was the bottle of pyrogallate of sodium?

A. Yes.

135 x-Q. The use of the cotton was simply to prevent the mechanical transportation of particles of dust or solid matter, was it not?

A. Yes. 4507

136 x-Q. The sulphuric acid tending to absorb moisture?

A. Yes, sir; and the ferrous sulphate to absorb any traces of oxide of nitrogen which might have been formed by overheating the retort.

137 x-Q. After the gas was so prepared, what means, if any, were used for purifying it before it was passed into the lamps?

A. The nitrogen gas was passed through another set of Wolff bottles containing a solution of sulphate of 4508 iron, then solution of caustic potash, then oil of vitriol, each solution being in two different Wolff bottles joined consecutively.

138 x-Q. What was the trouble, if any, with this apparatus which resulted in the use of your apparatus?

4509

A. The original cause of the trouble I never was made conversant with, except that Mr. Sawyer and Mr. Man were under the impression that trace of moisture was in the nitrogen gas after it was in the lamps, and the problem as stated to me was to deprive this nitrogen gas of all traces of moisture. This, I found, could be done by the use of phosphoric anhydride which, if I recollect, I took out a patent for.

139 x-Q. What, from your experience, would be the effect upon the life of the lamp of the presence of
4510 traces of moisture in the nitrogen gas?

A. I think that moisture in the nitrogen gas in the globe when brought in contact with the incandescent carbon at a white heat, would be converted into oxygen and hydrogen. This dissociation, if once taken place, the oxygen would be free to unite with the carbon to form carbonic acid and the pencil speedily destroyed.

140 x-Q. And this it was the object of your invention or use of the phosphoric anhydride to prevent?

4511 A. Yes, sir; the phosphoric anhydride was used to prevent the presence of moisture in the lamps in conjunction with the other dryers.

141 x-Q. You stated that after you began filling at 40 Broadway that later on with experience the work was more satisfactory. What do you mean by that?

A. I mean, first, that the experience showed that speed in filling was an essential, and also the experience of working in the shop producing a better contact of the carbons.

4512 142 x-Q. Do I understand that you mean by speed in filling the lamps that the lamps had to be filled and sealed very quickly, or that you had to have a very rapid flow of nitrogen through the lamps in order to sweep out the air?

A. No, sir. The speed spoken of refers to the pas-

4513

sage of the gas through the purifying apparatus, the absorption of impurities being more perfect at a slow rate of speed than fast. I would say right here that when I substituted a cylindrical glass vessel for holding the sodium, the latter being placed on a sand bath, if the rate of flow of the gas was too fast, or if the gas had not been properly purified from oxygen the metallic sodium would catch fire. Of course this would only take place when there happened to be
oxygen in the gas. 4514

143 x-Q. It is a matter of easy practice or a matter requiring considerable experience to prepare and purify nitrogen gas so as to deprive it of oxygen, either alone or in combination, and from moisture?

A. Taking the text books on chemistry as a standard, the process is a simple one and not difficult; but to deprive the nitrogen of the last traces of oxygen the use of sodium, as above indicated, is essential in my mind, which does not necessarily complicate the apparatus
materially, and in a chemist's hands a simple operation. 4515

144 x-Q. In your answer to question 14 you mentioned the straight Carré carbon as used by Sawyer and Man. What kind of a carbon was that and in what shape was it used?

A. It was a carbon called the Carré carbon, imported from Paris, and was used in all the different forms of the carbon pencils, except the arch, which was a paper carbon. It was retort carbon. I knew they ran out of it once and had to cable over.

145 x-Q. What kind of a carbon was the hollow wil- 4516
low carbon mentioned by you in the same answer to question 14.

A. It was a straight cylindrical hollow carbon made from willow.

146 x Q. You state that the carbon was hollow. What had been removed to make the carbon hollow.

4517 A. The interior carbon had been removed by mechanical means.

147 x-Q. I ask you to read on page 70 and 71 of Sawyer's book on electric lighting, already in evidence, beginning on page 70 where the description of boat-shaped carbons is commenced, and state whether the hollow willow carbons mentioned by you are the same or different from the carbons there mentioned in the book?

A. They are different. The hollow willow carbon
4518 being a hollow cylinder, whereas the boat-shaped carbon is a straight pencil, concavo-convex in cross-section, the centre of the carbon being slightly larger than the base.

148 x-Q. How much, if any, of the original willow was left in these hollow willow carbons as you call them?

A. I could not answer that. I didn't make the carbons.

149 x-Q. How did you know that they were hollow willow carbons?

4519 A. Nearly every lamp sent down to be filled was sent with a note describing the lamp. At the factory, before I filled the lamps at 40 Broadway, the lamps were running after being filled with the gas were subject to close examination by Mr. Sawyer and Mr. Man, myself and others who were interested, and the proficiency of the lamp always made a discussion as to the different forms of carbon which would be described at that particular time while the lamp was running.

149½ x-Q. What do you mean by the expression
4520 "treated" in your answer to question 14?

A. Mr. Sawyer had a process of depositing carbon in a very fine state of division upon pencils of coarser material by decomposition of hydro-carbon, this coating being very hard and uniform. The term "treated" referred to a carbon which had thus been exposed to his process.

150 x-Q. What do you mean by the expression "pencils of coarser material" in your last answer? 4521

A. I mean carbon, the particles of which were coarser than the carbon deposited by the process.

Adjourned to April 4th, 1889, at 10 o'clock A. M.

NEW YORK, April 4th, 1889, 10 A. M.

Met pursuant to adjournment. 4522

Present: Thomas B. Kerr, of counsel for complainant, and Walter K. Griffin, of counsel for defendant.

151 x-Q. What do you mean by the term "plain arch" in your answer to question 14?

A. That simply refers to the arch shaped carbon which was plain in its appearance. My impression is that there were a few carbons made of the arch form from hard carbon, by one of the men in the shop; but by the plain arch I understand the paper carbon. 4523

152 x-Q. Is there any difference between your use of the term "plain arch" and your use of the term "horseshoe paper carbon" in question 14?

A. No, sir.

153 x-Q. In your record of lamp tests under date of January 9th there is an entry of one lamp as No. 2 crescent. What form do you recollect as indicated by that term?

A. The same form as the arch, that being a term of my own used at that time?

154 x-Q. In the hammer and anvil lamps, what class of carbon was used? 4524

A. Straight pencil carbon, both treated and untreated. The kind of carbon was both hard carbon and willow carbon, so far as I recollect. I am positive these two materials were used.

4525 155 x-Q. In your answer to question 46 you state that several of the lamps burned finely for a number of days. Do you know of your own knowledge what was the material of the carbon in these several lamps?

A. My knowledge concerning the carbon in these lamps is the same as of the others.

156 x-Q. Are you able to swear that any one of the several lamps mentioned by you in your 46th answer were paper carbons?

4526 A. My knowledge relating to the paper carbon would be the same as that relating to the other carbon, and the lamps could not burn successfully at the factory without being filled with nitrogen gas by me at that time. I was therefore cognizant of all the forms of carbon in the lamps which were filled. Some of the lamps which burned successfully were of paper arch form.

157 x-Q. Do I understand that you substantially filled all the lamps during the period you were em-
4527 ployed to fill the lamps?

A. Yes, sir.

158 x-Q. How old a man was Mr. Myers at this time?

A. About twenty years, I should judge—about twenty or twenty-one.

159 x-Q. How did you come to testify in this suit?

A. President Morton of the Steven's Institute told me that the Westinghouse Company desired me to fill some of the old form of Sawyer lamps with nitrogen
4528 gas and that I should get ready to do the same by getting the apparatus together, as the lamps would be ready for charging in a few days, and in the course of a conversation which I had with him, it appeared to him that my former work in this line would be of interest to the company.

160 x-Q. Were the lamps brought to you to be filled?

A. They were not; I expect them any moment at the Institute. 4529

161 x-Q. Were you in any way retained by the Westinghouse company?

A. President Morton secured my services for the Westinghouse people as expert in the filling of the globes with nitrogen.

162 x-Q. Do you expect to be called in this suit as an expert?

A. I do. 4530

163 x-Q. How long ago was it Professor Morton spoke to you?

A. Ten days or two weeks, about, I should say.

Re-direct Examination by Mr. Kerr:

164 R-d. Q. Please state where the chemical apparatus was placed in the Walker street shop?

A. It was placed on the bench—a portion of it—and the dryers and purifiers on the partition in the shop between the front and back rooms. There was a table 4531
against the partition, and sometimes the generating apparatus was placed on the table and sometimes it was upon the adjacent end of the workmen's bench.

THOMAS B. STILLMAN.

Examination closed.

THOMAS B. STILLMAN, being recalled on the part of the complainant, testifies as follows in answer to interrogatories by Mr. Kerr.

165 Q. Please state whether you, at any time or 4532
times recently, visited the Sawyer-Man Electric Company's factory in New York; and if so, whether you there saw apparatus for producing and filling incandescent electric lamps with nitrogen gas?

A. I have. I was there two or three times recently, saw lamps being filled by the apparatus similar to the

4533
one I used ten years ago for filling the lamps with nitrogen gas, I don't think that I saw any apparatus for making the gas during these visits. The nitrogen gas was already in the bags made when I was up there. The method of making the gas was the same as I used, however, namely, by chloride of ammonium and nitrate of potash.

166 Q. Please state how long ago those visits were made?

4534 A. One was made about three weeks ago, the other last week, or the week before last.

167 Q. What was the object of your last visit?

A. To fill some lamps with nitrogen gas personally by the same process I used ten years ago.

168 Q. Did you do so, and if not, why not?

A. I could not do so as a portion of the apparatus was broken.

169 Q. Did you see any of the lamps burning during either of these visits, and if so, state whether they dif-
4535 fered, so far as you could see, from the lamps you filled in 1879?

A. I saw some of the lamps running that were filled with nitrogen, and I could see no difference in their construction and those I filled in 1879, of the same character.

170 Q. How did they appear to burn?

A. All right.

171 Q. State whether or not you have recently been at the works of the Westinghouse Electric Company, at
4536 Pittsburgh, and if so, for what purpose?

A. Yes, sir, I was there on Monday of this week to examine the apparatus used there for filling the lamps with nitrogen gas, to see the lamps that were running filled with gas, and also to see a lamp put together and filled by myself in the same manner as I used before, and to see the lamp tested and run after it was filled.

4537

172 Q. What did you do on that visit with reference to making nitrogen gas, filling and testing the lamps?

A. I made nitrogen gas, purified it, charged the lamp in the same manner as before, and left the lamp running in perfect condition when I left Pittsburgh.

173 Q. How did the apparatus for making nitrogen gas, purifying it, and filling the lamps which they had in Pittsburgh, and which you used on Monday last in the filling of the lamp, compare with the apparatus
used by you for similar purposes for Sawyer and Man 4538
in 1879?

A. There was no material difference.

174 Q. Please look at the map now shown you, marked Complainant's Exhibit, Stillman Lamp, and state whether or not that is the same or similar to the lamp you filled last Monday?

A. The lamp is similar to the lamp filled last Monday. I have not seen the lamp since Monday, but I believe it to be the same.

175 Q. You spoke of seeing this lamp put on a cir- 4539
cuit and burned. How did it operate?

A. Very successfully.

176 Q. How did its operation compare with those which you filled for Sawyer and Man in 1879?

A. The lamp burned successfully. I can't compare it with the other lamps. The lamp at present is in perfect condition, and a comparison could not be made unless the life of the lamp was given also, that is to say, this lamp may burn six weeks or two months,
as some of the Sawyer-Man lamps did, and this re- 4540
quires a comparison, as I stated before, of the life of lamps.

177 Q. My question was intended to relate only to the appearance of the lamp while you saw it burning, and I would like to know whether it burned during that period in any way different from the lamps which

4541 you tested successfully for Sawyer and Man after filling them in 1879, your test, as I understand, lasting from thirty minutes to an hour at that time?

A. The lamps which I tested in 1879, after filling and during the filling for a half hour or more in each instance, were brought up to a state of low redness. This, however, stood the test for the same period of time, giving out a much brighter light.

178 Q. How did its appearance while burning com-
4542 pare with the similar lamps you saw burning at Sawyer and Man's factory?

A. I have no means of deciding that point definitely, but I judge its appearance was about the same.

179 Q. Did you see any other lamps of this construction burning at the Westinghouse factory last Monday?

A. I did.

180 Q. How did they appear to burn?

A. All right.

4543 181 Q. Please state why the lamps you tested in 1879 were brought up to a state of low redness?

A. To drive out any occluded gases, and also as a means of testing whether the globe was properly charged, since by keeping the carbon incandescent the nitrogen gas containing oxygen for half an hour or more, combustion would ensue, which would show itself by the destruction slowly of the carbon. If much oxygen was present, the destruction was very rapid.

4544 *Cross-examination by* Mr. Griffin.

182 x-Q. When you went to the New York Sawyer-Man factory, and when you went to the Pittsburgh factory, I understand that the apparatus employed for making the gas and filling the lamps, was the apparatus and process invented by you and patented to you in two several patents taken out in 1880 in this country. Is that so?

4545

A. No, sir.

183 x-Q. What difference was there between the apparatus patented to you and the apparatus you saw?

A. There was no patent for the manufacture of nitrogen gas.

184 x-Q. Did you not take out one patent for the purification of nitrogen, and one patent for the process of filling the lamps with nitrogen?

A. Yes, I did.

185 x-Q. And one of those patents was numbered 4546
227,530, for your method of manufacturing the gas, dated March 23d, 1880, and the other was numbered 227,45?, dated May 11th, 1880, for apparatus for charging the lamps.

A. I believe so.

186 x-Q. As far as any difficulty in filling lamps with nitrogen by your process is concerned, do you know any reason requiring your presence and assistance at either factory in order to insure the proper filling of the lamps? 4547

A. No, sir; not after looking over the specifications of the patents.

187 x-Q. What would be the effect with your apparatus upon the glass tube holding the sodium, if it was started up and heated, after, by any means, a leakage of air had entered into the apparatus?

A. The sodium would be changed to oxide of sodium and the efficiency of the sodium would be deteriorated if enough air should be allowed to enter the apparatus to combine with all the sodium present. 4548
This, however, is a contingency which should not arise.

188 x-Q. The special object of your use of melted sodium was to insure the absolute consumption of all air or oxidizable matter before the gas was passed on to fill the lamps?

4549 A. It was.

189 x-Q. When you say you saw lamps in New York at the Sawyer-Man factory which were filled with nitrogen, you mean simply that from the surroundings and the apparatus you saw, and what was told you, you saw no reason to doubt the gas was nitrogen?

A. Yes, sir.

190 x-Q. Please look at Complainant's Exhibit Saw-
4550 yer-Man Broadnax Lamp No. 2. already in evidence in this suit, and say whether that resembles any of the lamps you filled in 1878 and 1879?

A. It resembles the lamps; yes, sir.

191 x-Q. I also ask you to look at Complainant's Exhibit Sawyer-Man Treating Apparatus, and to state whether that apparatus, so far as regards the radiators, the upper disc, and the arrangement of the clamps, resembles any of the lamps filled by you for Sawyer and Man in 1878 and 1879?

4551 A. My impression is that I filled lamps similar to this in construction.

192 x-Q. Are you able to say whether there is any difference in the upper part of that Sawyer-Man treating apparatus, and the lamps which you remember filling?

A. As I stated before, lamps were already set up and in proper condition to be filled with nitrogen gas by me. Otherwise than that I cannot state in regard to this lamp.

4552 193 x-Q. You stated that lamps having arch-shaped carbons were filled by you. Can you point out any difference in the radiators, the discs, the uprights, or any of the upper portion of that exhibit which, to your recollection or knowledge, differs from the lamps having arch-shaped carbons which you filled?

A. As I stated before, various forms of carbons and

lamps were sent down to be filled, some containing the soapstone upper base and others containing a metallic base insulated by means of mica. If my recollection is correct, I have filled some of these lamps like the sample; but my impression is that after January, 1879, I saw but few in which the bolt and nut went through the clamps. 4553

194 x-Q. Otherwise do you notice any difference between the arrangement in any way, either as to the size or as to the relation of the parts between 4554
the upper part of the exhibit just now shown you, and the upper parts of the lamps, that you recollect as having arch-shaped carbons?

A. There were a number of small changes made in the lamps from time to time which I do not recollect, but which, if brought to me, I might remember.

195 x-Q. When you say that the lamps which you saw at Pittsburgh and New York resembled the lamps which you filled in 1879, you do not mean to assert an identical construction, but in general appearance 4555
they resembled the lamps which you filled in 1879?

A. The lamps which I filled in 1879 consisted of various forms of carbon, and the lamps which I saw running at the New York factory and the Pittsburgh factory were identical in form and construction with some which I saw in 1879.

196 x-Q. Do you mean that the lamps were identical in their construction?

A. So far as I could remember, I should say that they were identical in construction. 4556

197 x-Q. Similarly is the upper part of the exhibit just shown you identical with the lamps which you filled in 1878 and 1879?

A. The lamps which I saw running in the factories in New York and Pittsburgh were identical with some of the lamps which I filled in 1879, but I do

5557 not recollect seeing this particular form running in the Westinghouse factory, though they may have been so.

198 x-Q. What I want to know is this, whether to the best of your recollection these two lamps, the Broadnax Lamp No. 2, presented during Mr. Broadnax's examination by complainants, and the exhibit Sawyer-Man treating apparatus, are more or less identical with the lamps which you filled in 1878 and 1879 than were the lamps you saw at Pittsburgh?

5558 A. My attention while at the factory in Pittsburgh was drawn more especially to the conditions of the carbons and their rate of burning than to the exact construction of the upper portion of the lamp, though there is a general resemblance to the lamps filled by me in that regard, consisting of a piece of carbon, arch-shaped, or otherwise, as an illuminant, connected between two large anodes or terminals. For this reason there may have been lamps of the description mentioned by you in circuit without my being able to say
5559 positively that they were there.

199 x-Q. What, again, I want to understand distinctly from you, is this: is your knowledge as to the identity of the Pittsburgh lamps, as to their upper portion, with the lamps which you filled in 1878 and 1879, any more or less accurate than your recollection about a similar identity of the two exhibits that have just been shown you?

A. In regard to the two exhibits, I can swear positively to filling lamps of that form, and I saw nothing
5560 in the lamps running at Pittsburgh which drew my attention to peculiarity of construction from the lamps which I had filled for Sawyer and Man.

200 x-Q. Was there anything in the lamps which you saw at Pittsburgh as to the construction of the upper part, which, to your recollection, differed from

the construction of the upper part of the exhibit treating apparatus? 4561

A. As I stated before, lamps of this construction might have been on exhibition there, but the lamp which I filled with nitrogen gas while there, or others similar to it, represented the bulk of the lamps running at Pittsburgh.

201 x-Q. What difference do you recollect as to the upper part of the lamps running at Pittsburgh and the upper part of the exhibit treating apparatus? 4562

A. As stated before, some of these lamps may have been in circuit, but the difference between this exhibit and the majority of the lamps running there of similar pattern consisted in the upper base not being of soapstone and no brass clamps through the upper carbons.

202 x-Q. What were used at Pittsburg through the upper carbon clamps?

A. The arch was placed down in the carbon holders and contact made by means of platinum.

203 x-Q. And what held the clamps together in the 4563
lamps at Pittsburg?

A. To my recollection there were no clamps.

204 x-Q. Didn't you see any lamps there with carbon clamps?

A. I do not recollect them.

205 x-Q. I ask you to look at the Stillman lamp. Are the clamps there not of carbon?

A. They are.

206 x-Q. Then the only difference that you recollect between the Stillman lamp exhibit and the Sawyer 4564
treating exhibit is in the change of the material of the upper disc from soapstone to metal with mica insulation?

A. Yes, sir.

207 x-Q. And outside of that difference, both exhibits, to your recollection, are equally identical, so far as

4565 you can now remember with the lamps you filled in 1878 and 1879 of this type?

A. Yes, sir.

208 x-Q. When you filled the lamps in 1878 and 1879, how long did you keep them on the bag, and flow the nitrogen through them before taking them off?

A. It depended upon the number of lamps in circuit, varying from one hour to four, depending upon the number of lamps in circuit.

4566 209 x-Q. What was the usual length for the lamps you had on circuit.

A. It would vary. Some days I would have one or two lamps and some days ten lamps.

210 x-Q. During the time you were with Sawyer and Man, which type of lamp did they consider in their conversation with you to be their most successful lamp? Was it not the straight pencil lamp?

A. That was a matter of considerable discussion at all times; but I don't think that that was definitely
4567 settled.

211 x-Q. Havn't you frequently expressed yourself as saying that Sawyer and Man had considerable more trouble with their horseshoe carbons than with the other types of lamps—the straight pencils?

A. I don't recollect that statement. I know that Mr. Man claimed that if the horseshoe carbon burned so successfully in the old shop for several months, there was no reason why others should not do the same. This old lamp I know nothing of personally.

4568 212 x-Q. To your knowledge, didn't they have more trouble with these horseshoe carbons than with the others?

A. I think not; but I could not state positively on that point for the reason that I never kept a record of the life of the lamps, and as I stated before, I don't think they did at the factory; that is, what we call a time book.

213 x-Q. You never knew of their keeping a record at all, did you? 4569

A. I think they would keep a record of a lamp which burned an extraordinary time; but if a lamp broke it would be set up and sent down to be filled.

214 x-Q. In other words when a lamp burned out or broke down for any reason, they would fix it up again and send it down to you to be refilled?

A. Yes, sir.

215 x-Q. And you cannot positively state how many 4570
times this was done with regard to any particular lamp?

A. No, sir; I can only distinguish between a lamp that had been filled once and a new lamp.

THOMAS B. STILLMAN.

4573 New York, January 24, 1890.

Met pursuant to adjournment. Present counsel as before.

Edward R. Knowles, a witness produced on behalf of defendant, being duly sworn and questioned by Mr. Broadnax, testifies as follows:

1 Q. Please state your name, age, residence and occupation.

A. Edward R. Knowles; 38 years old; residence 439
4574 Waverly Avenue, Brooklyn; and am a civil and electric engineer by profession.

2 Q. Please state whether or not you were acquainted with Wm. E. Sawyer in his lifetime?

A. I was.

3 Q. Please state when and where you made his acquaintance?

A. I first met Mr. Sawyer about 2d Nov., 1878, at his laboratory, No. 94 Walker Street.

4 Q. Please state whether you are acquainted
4575 with Albon Man, and when and where you made his acquaintance?

A. I am acquainted with Mr. Man. I first met Mr. Man on or about 2d Nov., 1878, at No. 94 Walker St., New York City.

5 Q. Please state whether you are acquainted with a certain incandescent electric lamp known as the Sawyer and Man lamp?

A. I am.

4576 6 Q. Please state when you first saw one of those lamps?

A. About the 2d Nov., 1878.

7 Q. At the time you first met Mr. Sawyer and Mr. Man, upon what business or work were they engaged?

A. As near as I know they were engaged in making electric lamps.

8 Q. Do you mean the Sawyer and Man electric lamps?

A. I do. 4577

9 Q. Did you ever see any of these lamps in operation, and if yes, say when and where and how many?

A. I have seen them in operation from time to time at No. 94 Walker street, shortly after November 2, 1878, and later on; how many I couldn't say.

10 Q. Please examine the Letters Patent of the U. S. No. 210,809 dated Dec. 10th, 1878, which I now hand you and state if you recognize the drawing making part of that patent?

A. I do. 4578

11 Q. State, if you know, who made the drawing and what it represents?

A. I made the original of the drawing and it represents one of the Sawyer and Man electric lamps.

12 Q. State, if you know, of what material the incandescent portion of the Sawyer and Man lamps were made?

A. Of carbon.

13 Q. State whether you have ever seen and examined any of the carbon illuminants used in these lamps? 4579

A. I have.

14 Q. State whether you have in your possession and can produce any of the carbons such as were used in the Sawyer-Man lamps as the illuminant thereof?

A. I have in my possession and can produce portions of carbons from which I believe the illuminants of the Sawyer-Man lamps were made.

Witness here produces four pieces of carbon. 4580

15 Q. Referring to the pieces of carbon which you have produced, please to give the length and diameter of the respective pieces of carbon you have produced?

A. The lengths are respectively about as follows, viz.:

4581 The longest about $\frac{3}{4}$ inches long.
The next about $\frac{5}{8}$ inches long.
The next about $\frac{1}{2}$ " "
The next about $\frac{1}{4}$ " "
And all about the $\frac{1}{32}$ in diameter.

16 Q. Where and when did you get these carbons?

A. At 94 Walker Street, sometime subsequent to November 2, 1878, and within a period of four or five months thereafter.

4582 17 Q. Of whom did you get them?

A. From Wm. E. Sawyer.

18 Q. What did Mr. Sawyer say to you when he gave you these carbons?

Objected to.

A. He gave them to me as a specimen of the carbon from which he manufactured the incandescent conductor for his incandescent lamp.

19 Q. Do you mean the Sawyer and Man lamp?

4583 A. I do.

20 Q. What was the length of these carbons at the time Mr. Sawyer gave them to you?

A. About six inches.

21 Q. In whose possession have these carbons been since Mr. Sawyer gave them to you?

A. In my own.

22 Q. Do you mean the whole of the time?

A. Yes, all the time.

23 Q. You say that these pieces of carbon when Mr.
4584 Sawyer gave them to you were about six inches long. How many such sticks of carbon did he give you?

A. Two or three.

24 Q. Where are these sticks of carbon that you think were about six inches long, when Mr. Sawyer gave them to you?

A. Broken up and lost.

25 Q. Are these carbons that you have produced fragments or pieces of such carbons that you say were broken up and lost? 4585

A. To the best of my belief they are.

26 Q. Why do you believe that they are?

A. When I received the two or three sticks from Mr. Sawyer, I carried them with me, and placed them in a drawer of my instrument box, where they remained until I went to look for them a short time since. When
I came to look for them, I found that they had been 4586
broken and most of them lost, and all that I could find were these four small fragments, which had lodged in a crack in the drawer. The drawer contained pens, pencils and other drawing utensils, and I suppose that during the lapse of so long a time, (some ten years or more) the constant using of these implements had broken the carbons up, and in taking the various utensils from the drawer, the fragments of carbon have been removed from time to time, until all I could find
were the few fragments which I have produced and 4587
which were lodged in the crack of the drawer and there stuck.

27 Q. Who was present, if any one, when Mr. Sawyer gave you these carbons?

A. I don't recollect of anyone being present.

28 Q. Did you see any of these carbons used as an illuminant in the Sawyer-Man lamps, and if so, please state when, as near as you can recollect?

A. I can't say. I have seen lamps with illuminants
in them and was told that they were made from similar 4588
carbons to these, but I do not know of my own knowledge that that was so.

29 Q. Referring to the carbon illuminants that you saw in the Sawyer-Man lamps, how did such illuminants compare in diameter with the carbons you have produced?

A. My recollection is that they were somewhat larger in diameter.

4589 30 Q. About how much larger? State as near as you can judge?

A. I should say from 1-64th of an inch to 1-32nd of an inch.

31 Q. Did you see such carbons in the lamp when the lamp was illuminated?

A. Yes, I did.

32 Q. How often did you see the lamps illuminated?

A. I should say 4 or 5 times, as near as I can recollect. Maybe more, maybe less.

4590 33 Q. When was this?

A. During the four or five months subsequent to the 2nd of November 1878.

34 Q. How much of your time, during that period, did you spend with Mr. Sawyer at No. 94 Walker street?

A. Very little. I went there as a draughtsman to receive orders or instructions from Mr. Sawyer as to certain drawings which I was making for him, and when such orders were received, I retired to attend to
4591 my own business.

35 Q. Referring to the original of the drawing making part of the patent No. 210,809, when did you make that drawing and for whom did you make it?

A. Between November 2nd and November 5, 1878, for Mr. Sawyer. Perhaps I made it for Mr. Broadnax and afterwards showed it to Mr. Sawyer; Mr. Broadnax was then the patent solicitor for Sawyer and Man.

4592 The carbon produced by the witness are here offered in evidence and the same are marked Defendant's Exhibit "Carbons produced by Knowles."

S. M. H.

Cross-examination by Mr. Seward:

36 x-Q. Excluding belief and its impressions, do you know that the fragments produced are a portion of the

samples of carbon sticks which Sawyer gave to you? 4593

A. I think they are.

37 x-Q. Is it not possible that during the ten or eleven years that such sticks were in the drawer occupied as you have stated, that they might have lost by attrition some portion of their original diameter?

A. I don't think so.

38 x-Q. And you think they are of the same diameter now as the were eleven years ago?

A. I do. 4594

39 x-Q. Did Sawyer tell you what portion of the Sawyer and Man lamp he invented?

A. I don't think he said anything to me definitely on the subject; he gave me to understand that he invented it jointly with Mr. Man.

40 x-Q. Did he never tell you what his particular contribution to the joint invention was?

A. No, sir.

41 x-Q. Did Mr. Man?

A. No. 4595

42 x-Q. Did you ever see, while at Sawyer and Man's, any attempt made to utilize any other substance than carbon as the incandescing conductor?

A. I don't think that I did.

43 x-Q. Did you see or hear of any disussion concerning the use of platinum as such conductor?

A. I don't remember.

44 x-Q. You were examined in the interference case in the Patent Office, were you not, between Sawyer and Man and Edison?

A. I was examined in some case; I think that was it. 4596
Yes, it was.

45 x-Q. You were also examined, were you not, in the suit known as the Pittsburgh suit, of the Consolidated Electric Light Company vs. the McKeesport Light Company?

A. I think I was, yes, sir.

4597 46 x-Q. Did you at any time, and if so when, invent an incandescent electric lamp, or any portion of one?

A. I did invent a lamp a good many years afterwards, when I was working for the Sawyer-Man Company, the Consolidated Electric Light Company.

47 x-Q. When?

A. I cannot tell you the date of it exactly.

48 x-Q. What year, what month, what season?

A. Somewhere prior to the 12th of October, 1882.

49 x-Q. Was that invention patented?

4598 A. There was a patent taken out on the various portions of an incandescent lamp.

50 x-Q. And of which portions you were the inventor?

A. Yes, sir.

51 x-Q. Who took out that patent?

A. Mr. Broadnax.

52 x-Q. In whose name was it issued?

A. In my own.

53 x-Q. Did you assign the patent or give the bene-
4599 ficial use of it to the Consolidated Electric Light Company?

A. I did not assign it, and own it now; I gave the beneficial use of it to the company while I was with them.

54 x-Q. Did the company manufacture and sell lamps made in accordance therewith?

A. They made some but never sold them.

55 x-Q. Of what material was the burner of such lamp composed?

4600 A. Of a variety of substances; of carbon.

56 x-Q. In your deposition as given in the Pittsburgh suit, above referred to, I find these questions and answers:

"12 x-Q. What was the carbon used in that lamp?

A. Quite a variety of carbons. They were made from paper, kitool, tampico, istle, patent fiber, bast and bamboo. 4601

13 x-Q. What was the material for the carbon adopted for commercial lamp of the company?

A. Bamboo.

14 x-Q. When was this adopted?

A. It was finally decided to use bamboo the 28th of March, 1883.

15 x-Q. When were the first commercial lamps 4602
put on the market, to your recollection?

A. The first lamps we put on the market were put in the United States Bank Building, corner of Wall and Broadway. I cannot give the exact date. I have got it, but not here.

16 x-Q. These were bamboo lamps, were they not?

A. Bamboo.

17 x-Q. How did the bamboo carbons in your
lamps differ from the bamboo carbons used in the 4603
Edison lamps?

A. They had no lugs on the extremities and were much heavier and lower in resistance, and were treated loops—treated carbons.

18 x-Q. Later on, how did the carbons used by you differ from the Edison bamboo carbons?

A. They never had any terminal lugs, were round in section, treated, and of a lower resistance than the Edison carbon.

19 x-Q. The treatment lowered the resistance, 4604
did it not?

A. It did, more or less. The carbons, when carbonized and before treatment, were always of quite low resistance, comparatively speaking. The treating process was principally used to equalize the resistance of the carbons and make them uniform.

4605 57 x-Q. Were those answers so given then correct?

A. They were.

58 x-Q. Having reference to the fragments of the Sawyer carbon sticks which you have produced, how did the carbons in the lamps made by the Consolidated Electric Light Company under the beneficial enjoyment of your patent compare in size with such fragments?

A. They were finer and longer.

4606 59 x-Q. In your former deposition you testified that you had been retained by the Westinghouse people; does that retainer still hold good?

A. Not that I know of.

60 x-Q. Has it expired?

A. I think so.

61 x-Q. Then you are no longer under the retainer of the Westinghouse people?

A. That is as I understand it.

4607 Adjourned till Saturday, January 25, 1890, at 11 A. M.

4609

NEW YORK, January 28, 1890.

Met pursuant to adjournment.

Present—Counsel as before.

Counsel stipulates as follows:

That the testimony of WILLIAM E. SAWYER beginning on page 163 and ending on page 182, both inclusive, of Volume III. of the printed record in the case of the Consolidated Electric Light Company vs. The Edison Electric Light Company and Thomas A. Edison, in 4610 the Western District of Pennsylvania, and also the deposition of Laurence Myers, beginning on page 164 and ending on page 167, both inclusive, of the same volume; and also the testimony of Ida Man Ives, beginning on page 1,032 and ending on page 1,037, both inclusive, of Volume II.; and also the deposition of Alice J. Watkins, beginning on page 1,038 and ending on page 1,041, both inclusive, of the same volume, may be printed as a portion of defendant's record herein, and read and used with the like effect upon the hearing hereof, as if regularly taken for the hearing of 4611 this suit.

It is also further stipulated that on the hearing hereof the plaintiff herein may read and use with like effect as if taken and introduced in evidence herein, any of the depositions and exhibits in the record of the foregoing suit, other than that of the experts taken therein, of which the complainant shall give notice to the defendant, at the commencement of the rebutting evidence that it is the intention of the complainant to 4612 use, and such depositions and exhibits as are put in shall be printed as part of the complainant's rebutting evidence.

If after such notification at the commencement of the rebutting evidence the defendant shall desire to add to its record any other depositions in the above-entitled case, than those already put in by it and by the complainant, the defendant shall be at liberty so to do, except the depositions of expert witnesses.

Adjourned to January 29, 1890, at 2 P. M.

4613

Deposition of Lawrence Myers in the McKeesport Case.

NEW YORK, April 12, 1881.

Parties met Pursuant to agreement.

Present--Counsel as before.

Counsel stipulate that no objection shall be taken to the testimony about to be put in, on the ground that sufficient notice has not been given either as to the
4614 time or names of the witnesses.

LAWRENCE MYERS, witness produced on behalf of Sawyer and Man, being duly sworn, in answer to interrogatories propounded by Mr. Broadnax, testifies as follows:

1 Q. Please to give your name, age, residence and occupation?

A. My name is Lawrence Myers; am 48 years of age; reside at Plainfield, N. J; my occupation is nego-
4615 tiating railroad bonds.

2 Q. Please to state whether you are acquainted with Wm. E. Sawyer and Albon Man, and if so, how long you have known them?

A. I am acquainted with both of them. Have known Mr. Man over twenty-five years; Mr. Sawyer about three years.

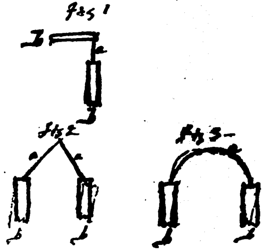
3 Q. Please state whether you are acquainted with a certain electric lamp known as the Sawyer and Man lamp?

4616 A. The lamp they had up to the latter part of January, 1879, I was acquainted with but don't know anything since.

4 Q. State whether or not you have seen that lamp in operation, and state where and when?

A. From the 13th December, 1878, to the 20th January, 1879, nearly every day, except Sundays, at 94

Lawrence Myers.



Sawyer Exhibit No. 5.
April 12. 1881.
W. H. B.
Notary Public.

Walker street (on corner of Walker and Elm streets), 4617
in City of New York.

5 Q. Is that the first time that you saw the lamp in operation?

A. I saw the lamp in operation previous to that in Centre street, somewhere near the Tombs, but I can't say exactly where; I saw it there only once.

6 Q. State, if you recollect, what form of burner was used in the lamp that you saw in operation in Centre street?

A. I do not recollect the form of burner; was the 4618
first electric light I ever saw, and was struck with the light, but don't recollect the form of the burner.

7 Q. Where did you next see the lamp in operation?

A. Corner Walker and Elm streets, at the place I have mentioned.

8 Q. State, if you please, what form of burner was used in the lamp that you saw at the corner of Walker and Elm streets?

A. There were several forms used; the principal 4619
ones were like those shown by this sketch. (Witness here makes a pen and ink sketch.) In this sketch, "*a*" in Fig. 1, represents a straight pencil of carbon; in Fig. 2, "*a*" "*a*" represent two straight pieces of carbon united at the top; in Fig. 3," "*a*." represents an arch-shaped carbon; and in all of the figures "*b*" represents larger pieces of carbon in which the burners "*a*" were held.

> Sketch offered in evidence as part of the 4620
> witness' testimony, and the same is marked Sawyer Exhibit No. 5, Apr. 12, 1881, W. H. B., Notary Public.

9 Q. Look at the drawing I now hand you, marked Sawyer Exhibit No. 4, March 17, 1881, and state

4621 whether you recognize that as representing one of the lamps you saw used by Sawyer and Man, corner of Walker and Elm streets, at the place referred to by you in previous answer?

A. Figs. 2 and 3 I recognize, and Fig. 4 is a side view of the same thing.

10 Q. State what these carbon burners were made of, if you know?

A. Some were made of willow; some cut out of block
4622 of carbon, and rubbed down with sand paper, and many other things, but I can't say exactly what.

11 Q. Did you see any of these made?

A. Saw them making them from various things; put them in a kind of crucible in a furnace; put molasses, etc., on the material; don't know what all.

12 Q. Did you see Mr. Sawyer or Mr. Man cutting out these carbons to the form represented by the sketch and put them in the lamp?

A. I did; I saw Mr. Sawyer principally; I don't
4623 know that I saw Mr. Man put them in the lamp.

13 Q. State, if you know, whether any of these carbon burners that you saw in use there were made of carbonized paper?

A. I do not know.

Cross-examination of witness by Dr. Dyer *of counsel:*

14 x-Q. Why did you go to Walker street every day to see these lamps?

A. Was requested to do so by the directors or trus-
4624 tees, whatever they were called, of the Electro-Dynamic Light Co.

15 x-Q. Did you have, or propose to have, an interest in the invention?

A. I did have; was stockholder in the company.

16 x-Q. How large were the carbon conductors which you have illustrated in your sketch, Exhibit No. 5, I mean the light-giving portion?

A. About the size of a good sized knitting needle; I 4625
refer to those in Figs. 2 and 3 particularly; that in Fig. 1 was usually as small as he could make it; it varied, however; was sometimes as large as the others.

17 x-Q. State, in detail, just what you saw Mr. Sawyer do when you saw him put carbons in lamps?

A. Seen him take a block of carbon and saw out the arch, sand paper or file it down to the size he wanted it, and put it into the holder and secure it there; file
out these two pencils in Fig. 2, weld them together and 4626
put them into the holder; make the pencil in Fig. 1 and put it into the holder.

18 x-Q. In each of these instances, after he had put the carbons into the holders, did he put them into lamps?

A. Yes.

19 x-Q. After that was done did you see him do anything with the lamps?

A. Saw him put them on the brackets, connected by
wires with the dynamo machine, and light it; that is 4627
the lamp.

Re-examination by Mr. Broadnax:

20 Q. How did the lamps operate?

A. I think every one of them gave a good light.

21 Q. This place that you speak of, as being on the corner of Walker and Elm streets, in this city, was that the workshop of the Electro-Dynamic Light Co.?

A. Yes, sir.

22 Q. And Sawyer and Man were there directing the 4628
work being done there?

A. Yes, sir.

23 Q. Were you an officer of the company?

A. I was a trustee; I mean a director.

24 Q. During the time you spent at the shop to which you have referred, was William Sawyer employed there; I mean the father of Wm. E. Sawyer?

A. Yes; during the whole of the time working on the lamps.

LAWRENCE MYERS.

4629 **Deposition of Ida Man Ives in the McKeesport Case.**

NEW YORK, April 1st, 1889.

Met pursuant to arrangement of counsel.

Present: Amos Broadnax, Esq., for complainant and Mr. Man; and Mr. Walter K. Griffin, for defendant.

4630 IDA MAN IVES being called on behalf of complainant, and duly sworn, testifies as follows:

1 Q. What is your name, age, residence and occupation?

A. Ida Man Ives, 33 years of age. I reside with my husband and father at 118 Putnam Avenue, Brooklyn. My father's name is Mr. Albon Man. My husband's name is Edward M. Ives.

2 Q. Where were you residing in the Winter, Spring, Summer, Fall of 1878 and Winter of 1879.

4631 A. With my father at his residence, 118 Putnam Avenue, Brooklyn.

3 Q. During that time do you recollect of Mr. Wm. E. Sawyer's visiting your father at his residence?

A. I do.

4 Q. When first did he visit your father there?

A. In the latter part of the Winter or Spring of 1878.

5 Q. Did he visit your father any time during the Summer or Fall of 1878?

A. He was there during the Fall of 1878.

4632 6 Q. State, if you recollect, how often he called to visit your father?

A. I don't recollect how often. He was there a number of times, and I recollect his dining there once.

7 Q. State whether or not you recollect of your father making any carbons in his house there at any time during the time mentioned by you?

A. Yes, I recollect seeing him in the Spring of 1878, making some carbons. That is what he said he was making. 4633

8 Q. State what, if anything, you saw used towards the making of such carbons.

A. I saw him put in little sticks and also pieces of paper in strips and rings—put them in a crucible and place that in the fire.

9 Q. What fire did he put them in?

A. In the range fire in the kitchen, and also in the laundry stove. 4634

10 Q. State what, if anything, he put into the crucibles besides the paper and sticks?

A. Some black-looking powder.

11 Q. Do you know what the black-looking powder was?

A. I do not.

12 Q. How often did you see your father do this?

A. As near as I can recollect, twenty or thirty times. 4635

13 Q. What, if any part, did you take in assisting him to prepare the paper and sticks that he put in the crucible?

A. I cut out the papers for him, and I saw him filing the sticks fine, smoothing them down.

14 Q. Did you assist him in that?

A. I didn't do it—simply saw him.

15 Q. What shape were the papers that you cut out for your father?

A. In strips about an eighth of a yard long—different widths and in rings. 4636

16 Q. What kind of paper was it that you cut up for your father in those shapes?

A. Blotting paper.

17 Q. What kind of blotting paper was it?

A. Ordinary white blotting paper, as I remember it.

4637 18 Q. Do you recollect of cutting up any other kind of paper?

A. No, sir.

19 Q. About how wide were the strips of white blotting paper that you cut up for your father?

A. Very narrow little fine strips perhaps about an eighth or a quarter of an inch.

20 Q. About what size were the rings of paper that you cut out for your father?

A. About the size of an ordinary spool of thread—

4638 the end of it.

21 Q. How long did these experiments of your father continue from the time he began?

A. Several weeks.

22 Q. What was the crucible like that he put the carbons in that he put in the furnace of the range?

A. I did not examine it. I think it might have been metal of some kind.

23 Q. Was it square or round; by round I mean cylindrical or conical?

4639 A. Round.

24 Q. Do you recollect of seeing him use a square crucible or box. If so, please to state whether it had a lid or how it was fastened?

A. Yes, I recollect of his using a square box of sheet iron or something of that kind, and he fastened the lid on by winding a wire or something of that kind, as I recollect.

25 Q. State, if you know, what these carbons were being made for by your father?

4640 A. For his electric light.

26 Q. Did your father tell you that at the time, or did you see them used in electric lamps?

A. He said he was making carbons. I saw the lights afterwards.

27 Q. Where did you see the lights?

A. At his shop in Walker street, New York. 4641

28 Q. How many of the lights did you see there?

A. Five or six.

29 Q. All burning at one time?

A. Yes, they were all burning at one time and turned on to different degrees of brightness.

30 Q. What shape were the carbons that were in those lamps that you saw?

A. A little longer than a half circle.

31 Q. Do you know whether or not any of these carbons were made of paper or sticks of wood such as 4642 you made for your father. State what your recollection of it is?

A. I do not know what they were, positively. I simply know what I was told.

32 Q. State what your father told you about it at the time?

A. All I know is that he told me the carbons were the same in the lamps as those that he made.

33 Q. State, if you recollect, whether or not you saw your father tie up any of the sticks that you or he 4643 prepared in the form of a bow or loop before he carbonized them?

Objected to as distinctly leading. Question withdrawn.

34 Q. State, if you recollect, in what form your father put the sticks before putting them in the crucible that had been previously prepared by you or him?

A. They were straight as I recollect. 4644

35 Q. How did you happen to visit your father's shop in Walker street?

A. He took me there with a party of friends to show us the lamp.

36 Q. With whom was your father working at that time on electric lights?

A. With Mr. Sawyer.

4645
37 Q. What time was it that you visited the shop in Walker street. When was it?

A. In the fall of 1878.

38 Q. Who went with you besides your father?

A. My aunt, Miss Watkins, and Mr. and Mrs. Greenough of northern New York.

Cross-examination:

39 x-Q. Can you state any more distinctly when you
4646 visited the Walker street shop?

A. I can't remember exactly. It was early in the Fall.

40 x-Q. How long was it after you had assisted your father as to the carbons?

A. It must have been four months, perhaps. It was early in the spring, March or April, when I assisted him. It was certainly September when I went to the shop, or later.

41 x-Q. What other shapes did you see at the shop,
4647 if any, besides the half circles?

A. I do not recollect any.

42 x-Q. Did you not see straight carbons?

A. I do not recollect.

43 x-Q. How long were you in the shop?

A. About half an hour, I think, perhaps longer. I don't know the exact time.

44 x-Q. And you think you saw about a half dozen lamps?

A. Yes.

4648
45 x-Q. And you didn't see any straight carbons?

A. I do not recollect any.

46 x-Q. How do you come to recollect the shape of the carbons at all?

A. Same as I recollect anything. I recollect it, that they were of that shape.

47 x-Q. What part of the shop were you in?

A. In the reception-room and in the workshop.

4649
48 x-Q. What kind of lamps were those that you saw at the shop?

A. They were a little glass globe—oblong globe—little fine looking wire inside the globe so far as I could see, with a band around the small end of the globe, and they were mounted on a bracket of some kind, I don't know exactly what.

49 x-Q. What did your father say to you, exactly, so near as you can now remember, as to the carbons?

A. Nothing that I recollect except that he was 4650
making carbons.

50 x-Q. That was at your house, was it not?

A. Yes.

51 x-Q. Who was in charge of the kitchen at the time?

A. My aunt, Miss Watkins.

52 x-Q. Who was the cook?

A. I can't recollect exactly. We changed girls several times. There was a girl there.

53 x-Q. Did not the same girl who was there in 1878 4651
remain there for several years afterwards?

A. No.

54 x-Q. How did you come to testify here? I mean who first spoke to you as to the matter?

A. I spoke first to my father.

IDA MAN IVES.

4653

Deposition of Alice J. Watkins in the McKeesport Case.

TESTIMONY OF ALICE J. WATKINS.

ALICE J. WATKINS being duly called in behalf of complainant, and duly sworn, testifies as follows:

1 Q. What is your name, age, residence and occupation?

4654 A. Alice J. Watkins, 44 years of age. I reside at 118 Putnam avenue, Brooklyn, in the family of Mr. Albon Man. His wife is my sister.

2 Q. Have you been present and listened to the testimony of your niece, Mrs. Ives, here this afternoon?

A. Yes.

3 Q. Please to state what, if anything, you recollect about the experiments of Mr. Man in making carbons at his house, and when it was that such carbons were made?

4655 A. It was in the winter and spring of 1878, he worked in the kitchen, and I remember his using a dish he called a crucible. It was a rough looking vessel, I thought, of iron. In it I saw him put bits of paper, pieces of sticks, a blackened powdered substance. That is all I can recall. I saw him cover it, and place it in the fire in the range. I don't know that I can recall any more in regard to it.

4 Q. What was the shape of the crucible, as near as you can recollect it?

4656 A. Round.

5 Q. How long did he leave it in the furnace of the range or other stove?

A. I don't recollect.

6 Q. Did you see him have more than one crucible?

A. I think so.

7 Q. How many do you recollect of his having?

A. Not more than two.

4657

8 Q. Were they both of the same shape?

A. The other was square.

9 Q. Did they both look like iron or clay?

A. I think so.

10 Q. State, if you recollect, what the shape of the paper and sticks were that he put in the crucible?

A. The paper was in narrow strips an eighth of a yard long.

11 Q. Were there any shapes of the paper?

A. I think in round rings. 4658

12 Q. Can you give the size of the rings as near as you can recollect?

A. No, I can't.

13 Q. What was the shape of the sticks?

A. As I remember, they were straight—of different lengths.

14 Q. How often did you see him prepare these papers and put them in crucibles?

A. Twenty or thirty times. I have a distinct recollection of his cutting the sticks, I meant to say preparing them. 4659

15 Q. What makes you recollect the fact of his making these carbons?

A. The amount of dirt and refuse I had to clean.

16 Q. Did you have charge of the housekeeping or kitchen department then?

A. Mostly.

17 Q. Did you visit the shop in Walker street along with Mrs. Ives and Mr. Man? 4660

A. I did.

18 Q. What did you see there?

A. I saw the electric lamp.

19 Q. How many do you recollect of seeing on that occasion?

A. Five or six.

20 Q. Did you notice the form of the carbon burn-

4661 ers in the lamp? If so, please to state what the form of the carbon burners was?

A. A little longer than half a circle, as I recall it.

21 Q. Did you notice whether any of the burners in those lamps were made of straight sticks of carbon?

A. I do not recall it.

22 Q. Do you recollect of Mr. Sawyer visiting Mr. Man's house?

A. I do.

4662 23 Q. State, if you recollect when his visits occurred?

A. The early Spring, I think, and then in the Summer, of 1878.

25 Q. How often did he visit there?

A. I can't remember, may be six times.

26 Q. Can you recollect what time in the year it was in 1878 that you visited the shop in Walker street?

A. In the Fall; it may have been September, somewhere about that.

4663 27 Q. These carbons that you saw in the lamps—I mean the carbon burners you saw in the lamps in the Walker street shop, how did they differ, if at all, from the paper carbons you saw Mr. Man make at his house?

Objected to as leading and suggestive.

A. I should think as near as I can recall it they were the same shape.

Cross-examination.

4664 28 x-Q. Were these lamps lit when you saw them?

A. They were.

29 x-Q. Who lit them for you to see?

A. I think they were lighted when we went there.

30 x-Q. Were they kept lit?

A. Yes.

31 x-Q. All the while you were there?

A. They were turned up and down to show different

4665 degrees of light.

32 x-Q. As I understand you they remained lighted all the time you were there?

A. Yes.

33 x-Q. Are you sure your visit was made before October, 1878?

A. I think so.

34 x-Q. Are you sure you did not see lamps with straight pencils? 4666

A. I said I did not recall them.

35 x-Q. You simply do not recollect them, if they were there. Is that so?

A. Just as I said, I do not recall them.

ALICE J. WATKINS.

4667

4668

4669 New York, February 8th, 1890.

Present—Parties as before.

Jacob Hays, a witness produced on behalf of the defendant, being duly sworn, and who having been examined in the case of The Consolidated Electric Light Company, complainant, against the McKeesport Light Company, defendant, in the Western District of Pennsylvania, counsel for the respective parties agree that his deposition given in that case, which is found in
4670 Volume I. of Defendant's Record, between pages 631 and 637 inclusive, shall be printed as a part of Defendant's Record in this case, and shall stand in evidence in this case the same to all intents and purposes as if it had been regularly taken herein; and it is further agreed that the objections which were printed in such Record in the McKeesport case shall be omitted in printing the deposition in this case.

The said witness being further examined in this case, says:

4671 1 Q. Referring now to the time referred to in your deposition in the McKeesport case, please state what, if anything, you did towards securing carbons from France, to be used as illuminants in the Sawyer-Man lamps; I mean in the fall of 1878?

A. Somewhere between October, 1878, and, I think, February, 1879—I cannot give you the exact time—but somewhere between those dates, I telegraphed to a gentleman in Paris, France, for some carbons. I think they were called Carré carbons. I soon after-
4672 wards received them either by mail or express, I forget which, and handed them to Mr. Sawyer, at 94 Walker street.

2 Q. Can you give the name of the person to whom you telegraphed?

A. I have forgotten it. It was some gentleman trav-

eling abroad—a friend of mine. I have tried to think 4673
of his name, but cannot remember it.

3 Q. Can you produce any specimen of those carbons?

A. No, I cannot.

4 Q. Can you give the dimensions of those carbons?

A. Yes, I remember the size very well. They were all sizes—that is, in length. Their thickness was about that of an ordinary inch brass pin.

5 Q. About as large in diameter as an ordinary pin? 4674

A. Yes, sir.

6 Q. A pin about how long?

A. About an inch pin. They were very fine carbons.

7 Q. How does the diameter of the carbons to which you have referred in your last answer compare with this now shown you?

A. These are about the size, certainly not any larger.

8 Q. Were any of them smaller than this?

A. No, I think that is about the exact size, as well 4675
as I can remember.

The carbons shown to the witness and referred to in his answer last given are the carbons produced by the witness Knowles.

9 Q. Did you see any of those carbons in the lamps of Sawyer and Man at 94 Walker street?

A. I saw carbons used in lamps, but I could not swear that they were the same carbons. 4676

10 Q. How did the carbons you saw used in the lamps compare in size with these carbons?

A. About the same thing.

11 Q. As near as you can judge?

A. Yes, sir.

12 Q. How often did you see the lamps of Sawyer and Man in operation at 94 Walker street?

A. I should think from four to five days in a week,

4677 from October, 1878, to February or March, 1889. I
was there nearly every day.

13 Q. Were you interested in these patents granted
to Sawyer and Man, or the patents known as the
Sawyer and Man patents?

A. Yes, sir.

14 Q. How many of these carbons were sent to you
from France at the time you telegraphed for them?

A. I do not recollect, but I should judge a couple of
4678 dozen.

15 Q. How long were such carbons?

A. They varied. Some ran 3 and 4 inches and
some 2 inches. They may have been broken on the
way.

16 Q. How did the lamps of Sawyer and Man operate
—those that you saw burning?

A. They seemed to operate well.

17 Q. How long is the longest time you saw any of
them burning?

4679 A. From two to three hours.

18 Q. As long as you stayed there?

A. Yes, sir.

Cross-examination by Mr. Seward.

19 x-Q. Which Mr. Sawyer do you refer to?

A. William E.

20 x-Q. Were you aiding him all that time in his
experiments?

4680 A. No, sir, I am a director of the Company—one of
the officers of the Electro-Dynamic Light Company.

21 x-Q. Had that Company then been formed?

A. Yes, sir.

22 x-Q. At whose expense did you cable to Paris?

A. I presume my own.

23 x-Q. At the request of Mr. William E. Sawyer?

A. Yes, sir.

24 x-Q. Did you know anything at that time of the

electrical requisites of a carbon burner for incandes- 4681
cent lamps?

A. No, sir, I did not.

25 x-Q. How did you receive the information that
there were carbons to be purchased in Paris or France?

A. I heard it from Mr. Sawyer.

26 x-Q. You say that you were interested in the
Sawyer and Man patents?

A. Yes, sir.

27 x-Q. Did you make any money out of that in- 4682
vestment?

A. Not so far back as that.

28 x-Q. I show you one of the lamps produced in
this case, marked "Case No. 3445, S. M. H., Ex., Jan-
uary 11, 1890," and ask you whether that is the type
of lamp to which you have referred in your direct ex-
amination as having been seen by you?

A. I don't think I saw that lamp. That is a differ-
ent lamp.

29 x-Q. I show you another exhibit introduced by 4683
the defendant, marked "Exhibit Sawyer and Man Lamp
for Horse Shoe Carbons, January 13, 1890," and ask
you if that is a type of the lamp you have referred to
on your direct examination?

A. That looks very much like one of them.

30 x-Q. Having reference to this last exhibit, can
you state where the carbon would be put therein?

A. No, sir; I could not. I am not practical enough
for that.

31 x-Q. Having reference to the first exhibit, can 4684
you say whether that now contains a carbon?

A. I should think the carbon was that little piece
between the upper and the lower part.

32 x-Q. Having reference to what you have correctly
designated as the carbon now in the exhibit, how does
such carbon in such exhibit compare with the length
of the carbons which you saw used in the lamps to
which you have testified in your direct?

4685 A. I could not say.

33 x-Q. Do you recollect whether any of the lamps of which you have spoken on your direct, and which you say you saw illustrated, has carbons longer or shorter than the one in the exhibit produced?

A. I have seen them of different sizes.

34 x-Q. How long and how short?

A I have seen them with a horse-shoe. I could not give the length. I think I have seen them all the way from half an inch to may be an inch, and then circled
4686 —curved.

35 x-Q. Did you see a full circle?

A. Yes, a full arch.

36 x-Q. You mean a horse-shoe shape?

A. Yes.

37 x-Q. Do you know of your own knowledge that any of the carbons sent in answer to your cablegram were actually used by Mr. Sawyer after their receipt in this country in any of the samples which you saw?

A. I could not swear that they were the carbons, ex-
4687 cept that Mr. Sawyer told me they were. He did treat them for that purpose.

38 x-Q. Mr. Sawyer told you that he had treated certain of the carbons imported for the purpose of using them in lamps?

A. Yes, sir.

39 x-Q. But you do not know of your own knowledge that any were so used?

A. No, sir.

4688 *Re-direct by* Mr. Broadnax:

40 R-d. Q. Have you any practical knowledge of the detailed construction of any of the lamps of Sawyer and Man?

A. No, sir.

41 R-d. Q. You only recollect them in a general way?

A. That is all.

4689

Deposition of Jacob Hays in the McKeesport Case.

It is agreed that the witness need not sign this deposition and that it shall be received in evidence as if he had signed it.

4690

Jacob Hays, a witness on behalf of the defendant, being duly sworn, says:

1 Q. What is your name, age, residence and occupation?

A. Jacob Hays; I am 44 years of age; I am retired from business and now in the management of railroads and steamboats.

2 Q. Are you the Jacob Hays named in the certificate of incorporation of the Electro-Dynamic Light 4691
Co.?

A. I am.

3 Q. Were you a director of that company in 1878 and 1879?

A. I was.

4 Q. As such director did you attend any of the meetings of the Board of Trustees?

A. I did.

5 Q. Did you attend all the meetings that were held?

A. I could not say positively, but a majority of the 4692
meetings.

6 Q. Were you an officer of the company during the years 1878 and 1879, other than a director?

A. I was.

7 Q. What office did you hold in that company?

A. I was the treasurer.

8 Q. State, if you know, who the other members of

4693 the Board of Trustees were during the years 1878 and 1879?

A. As near as I can remember, Mr. Albon Man, Mr. William E. Sawyer, Hon. Hugh McColloch, Lawrence Meyers, William H. Hays, and I think James P. Kernochan, were members of the Board of Directors.

9 Q. Are any of the persons named by you in your last answer deceased?

A. William H. Hays, William E. Sawyer are deceased.

4694 10 Q. Do you know where Mr. Lawrence Meyers resides or now is?

A. He resides in Plainfield, N. J.: now visiting Colorado.

11 Q. Do you know as to when Mr Meyers is likely to return from Colorado?

A. I do not.

12 Q. Do you remember where the Hon. Hugh McColloch now resides?

A. Washington, D. C. A little out of Washington.

4695 13 Q. Who was president of the Board of Trustees of the Electro-Dynamic Light Co., and who its secretary, during the years 1878 and 1879?

A. Mr. Albon Man was the president and Mr. Wm. E. Sawyer was secretary. I cannot say positively that they remained in office throughout the year 1879.

14 Q. Can you say whether Mr. Wm. E. Sawyer was the secretary of the Electro Dynamic Light Co. during the month of March, 1879?

A. My impression is that he was.

4696 15 Q. Do you remember whether Mr. William E. Sawyer was present and kept a record of the proceedings of the meetings as secretary, on the occasions when you attended them?

A. Mr. Sawyer was the secretary at all the meetings and took down the minutes in shorthand. He was a stenographer.

4697

16 Q. Do you know whether he transcribed his minutes after they were so taken, into any minute book or record book of the company?

A. He did.

17 Q. Do you now remember of having seen or examined, in 1878 or 1879, the minute book of the Electro Dynamic Light Company in which Mr. Wm. E. Sawyer recorded the proceedings of the Board of Trustees of said company?

A. I have seen it, but do not remember whether I 4698
ever examined it.

18 Q. When and where did you see said book of minutes; while Mr. Sawyer was president of the Electro Dynamic Light Co.?

A. At the office of Classon & Hays, No. 3 Nassau street, where the meetings of the company were held.

19 Q. When last did you see said book of minutes, and in whose possession was it?

A. Yesterday. Two or three days ago. Mr. Donnelly and a gentleman with him called at my office, No. 4699
11 Pine street, and asked me the question as to where the minute book of the Electro Dynamic Light Company was; I told him I did not know; his manner excited my curiosity, knowing he was a lawyer; I immediately called upon Mr. Hugh R. Garden, knowing he was the president of the Electro-Dynamic Light Co. I informed him of the conversation which took place between Mr. Donnelly and myself. I asked Mr. Garden if he knew where the minute book was. He told me 4700
he did, and that it was in his possession.

20 Q. Where was the business of the Electro Dynamic Light Co. carried on in March, 1879?

A. 94 Walker street.

21 Q. Do you now remember the names of the persons then in its employ, other than its officers or directors?

A. Mr. Sawyer's father and a Mr. Myers, whose first

4701 name I do not know. A young man now dead, as I am informed. There were other persons employed, but I do not remember their names.

22 Q. Do you remember whether or not the Electro Dynamic Light Co. suspended, or partially suspended, its business operations in or about the month of March, 1879?

A. They partially did suspend.

4702 *Cross-examination:*

23 x-Q. What was the reason of that suspension?

A. On account of Mr. Wm. E. Sawyer's bad habits.

24 x-Q. In what respect?

A. He was a drunkard and kept company with bad characters.

25 Q. What effect had that upon his work?

A. It kept him from the attention he should have given to his business.

4703 26 x-Q. What was the feeling of the board as to the matter of continuing operations under Sawyer's management?

A. They were disgusted with him on account of his habits and inattention to business, and placed in charge Mr. Lawrence Meyers the management, and also for the purpose of trying to keep Mr. Sawyer straight.

27 x-Q. Was Mr. Lawrence Meyers an electrician or mechanic?

4704 A. He was not.

28 x-Q. What was the character of Mr. Sawyer's workmanship during this period—was it good or bad?

A. It was good.

29 x-Q. What railroad and steamboats have you management of, and in what capacity?

A. I am the vice-president of the Eighth and Ninth

Avenue Street R. R. of this city, and treasurer of the People's Line of Steamers, known as the N. J. Steamboat Company, running from N. Y. to Albany and return. I am also a director and member of the Executive Committee of the Brooklyn and New York Ferry Company. I am a member of the N. Y. Stock Exchange. 4705

30 x-Q. Who was Wm. H. Hays?

A. He was my father.

31 x-Q. What was his business and his position generally in New York? 4706

A. He was president of the Bank of the State of New York, president of the Eighth and Ninth avenues surface roads of this city, and interested in other institutions and corporations.

32 x-Q. Who is Mr. Lawrence Myers, and what is his standing and position in N. Y.?

A. Mr. Lawrence Myers is a gentleman of wealth and retired from business, and is at this time the receiver of the Richmond and Allegany R. R.

33 x-Q. Who is the Hon. Hugh McColloch? 4707

A. A gentleman of national reputation, having been twice Secretary of the United States Treasury, and a man of wealth.

35 x-Q. Who is Mr. James P. Kernochan?

A. Mr. Kernochan is a gentleman of wealth. Stands very high, and retired from business, and is connected with the well-known Lorrillard family of this city.

35 x-Q. Who is Mr. Albon Man, and what has been his standing and connection in this community during your acquaintance with him? 4708

A. Mr. Man is a gentleman, and a lawyer by profession, and was for a number of years manager and agent of the Lorillard estate.

36 x-Q. How do you know that the business of the Electro Dynamic Light Co. was carried on at 94 Walker St.?

4709

A. Because I spent considerable time at the office; on an average, four times a week.

37 Q. What did that business consist of?

A. Experimenting on electric lights and making them.

38 x-Q. Did you ever see any of these lights there?

A. I did.

39 x-Q. In process of manufacture?

A. Yes.

4710 40 x-Q. Any of them in use there?

A. Yes.

41 x-Q. How did they work?

A. They worked well.

42 x-Q. Then it was not on account of the character and operation of the lamps that the company suspended operations, was it?

A. It was not.

Re-direct:

4711 43 Re-d Q. Are you now a director and stockholder of the Consolidated Electric Light Company, the complainant in this suit?

A. I am.

44 R-d. Q. You were not a practical electrician or an electrical engineer in 1879, were you?

A. I was not.

Re-cross:

4712 45 R-x-Q. What leads you to say, then, that the lamps worked well?

A. Because I was constantly at the office, 94 Walker street, and saw them in use and giving such beautiful light.

JACOB HAYS.

Sworn to before me this 8th day of March, 1888.

JOHN H. KITCHEN.

4713

UNITED STATES CIRCUIT COURT,

SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT COMPANY

against

THE UNITED STATES ELECTRIC LIGHTING COMPANY. 4714

ANSONIA, Conn., February 12, 1890.

Before SAMUEL M. HITCHCOCK, Examiner.

Met pursuant to agreement.

Present—RICHARD N. DYER, Esq., of Counsel for 4715
Complainant. J. EDGAR BULL, Esq., of Counsel for Defendent.

CHARLES H. HAYES, being first duly sworn, on behalf of the defendant, testifies as follows:

1 Q. What is your age, residence and occupation?

A. My age is 54; my residence Ansonia; Electrician.

2 Q. Please state by whom you are now employed?

A. By the firm of Wallace & Sons of Ansonia, Conn.

3 Q. How long have you been in their employ? 4716

A. Since 1865 with the exception of about a year, or a year and a half. I think the latter part of 1867 and the year 1868 I began.

4 Q. Were you acquainted with Mr. William E. Sawyer?

A. I was.

5 Q. Under what circumstances did you meet and know Mr. Sawyer?

4717

A. On the occasion of his being engaged at the factory of Wallace & Sons in work on incandescent lamps.

6 Q. Please state if you know when Mr. Sawyer went to Wallace's and began work on incandescent lamps?

A. I know he was there the first day of May, 1879.

7 Q. I place in your hands a piece of carbon about two inches in length; please state if you have ever seen this piece before and if it has ever been in your pos-
4718 session?

A. I have seen this piece before, or another exactly like it, and fully believe this piece to have been in my possession for a number of years.

8 Q. Please state when and under what circumstances you parted with the possession of the piece you hold in your hand?

A. On the 24th day of January last I was asked by Mr. Bull if I knew where there was a piece of the carbon used in the Sawyer lamp. I took a piece from a
4719 drawer where it had been for a long time, broke off this piece and gave it to Mr. Bull.

9 Q. What was the length of the carbon from which this was broken?

A. About six and a half inches.

Carbon referred to by witness in the above answers is offered in evidence and marked "Hayes carbon No. 1."

4720 10 x-Q. I observe that the exhibit Hayes carbon No. 1, has a greyish or silvery appearance; state, if you know, to what this is due.

A. It was caused by the process of treatment by an electric current applied to the carbon when it was immersed in oil; or something of that sort. I understood it to be oil.

11 Q. State, if you know, whether Mr. Sawyer

4721

while he was here was in the habit of treating carbon by the process described in your last answer?

A. He was. I saw him doing so many times.

12 Q. Please state whether to the best of your knowledge and belief this exhibit "Hayes carbon No. 1" is a piece of one of the identical carbons treated by Mr. Sawyer while he was at the Wallace's?

A. To the best of my knowledge and belief it is.

13 Q. Did you or did you not see Mr. Sawyer while he was at the Wallace's use carbons of the cross-section of the carbon exhibit "Hayes carbon No. 1." 4722

A. I did, as near as I can judge by the eye without measuring it.

14 Q. Please state what is the diameter of "Hayes carbon No. 1."

A. I measured it with a micrometer and found it to be $31\frac{1}{2}$ one-thousandths of an inch.

15 Q. I place in your hands another piece of carbon of about the same length as "Hayes carbon No. 1;" please state if you have ever seen this piece before, 4723
and if it has ever been in your possession?

A. I have seen it and it has been in my possession.

16 Q. Please state when you parted with the possession of this piece?

A. On the morning of February 11th—yesterday.

17 Q. State if you know how long this carbon has been in your possession.

A. I know it has been in my possession for the last six years, how much longer I am unable to say. 4724

Specimen offered in evidence and marked "Hayes Carbon No. 2."

18 x-Q. I place in your hands a broken piece of apparatus; please state whether you have ever seen this before, whether it has ever been in your possession—if yes, when you parted with such possession?

A. I have seen it before. It has been in my pos-

4725

session and I parted with it January 24, 1890, when I gave I gave it to Mr. Bull.

19 Q. Please state how long it had been in your possession when you gave it to me?

A. I am unable to say how long. It had been laying about my shop for a number of years.

20 Q. Please state if you know what this broken piece of apparatus is.

A. It is one of the Sawyer incandescent lamps made
4726 at the factory of Wallace & Sons.

Lamp referred to by witness offered in evidence and marked "Sawyer lamp produced by Hayes."

Cross-examined by Mr. Dyer.

21 x-Q. Is your recollection as to the length of possession by you of carbon No. 1 any better than your recollection as to carbon No. 2?

4727 A. It is the same.

22 x-Q. In the exhibit "Sawyer lamp produced by Hayes" there still remains a piece of carbon pencil does there not?

A. There is.

23 x-Q. How does the diameter of this piece appear to compare with the diameters of the two separate pieces you have produced?

A. The fragment in the lamp is larger than the others.

4728 24 x-Q. You say that you know Mr. Sawyer was here working at the Wallace's on the first of May, 1879. Do you mean to fix that as the date he commenced work here?

A. That is the earliest date I can fix.

25 x-Q. Did Mr. Sawyer come alone to Ansonia, or did he bring workmen with him from New York?

A. I think he came alone at first, later on there were workmen here that I suppose he brought.

4729

26 x-Q. Was William Sharp one of these workmen?

A. He was.

27 x-Q. What were Sharp's duties when he came, if you know?

A. I do not know positively, but understood him to have come for building these Sawyer lamps.

28 x-Q. Did Mr. Sharp remain here upon that work as long as the work was continued?

A. I do not know. I know that he remained here 4730
in the employ of Wallace & Sons for several years, but don't know that he remained upon that work until it was finished for I knew but little about that work.

29 x-Q. You were not engaged upon that work yourself then?

A. I was not.

30 x-Q. Mr. Sharp, then, you understand was directly connected with this work and knew about it?

A. I so understood.

4731

Re-direct by Mr. Bull.

31 R-d Q. In Question 13 I asked you whether you saw Mr. Sawyer while he was at Wallace's use carbons of the cross-section of the exhibit "Hayes carbon No. 1," and you replied that you did, as far as you could judge by the eye without measuring it. What use did you see Mr. Sawyer put such carbons to?

A. I saw them used for the incandescent portion of the lamps he was trying or running.

32 R-d Q. Did you ever see him illuminate lamps 4732
other than feeder lamps, as they are called, of which the lamp marked in evidence "Sawyer lamp produced by Hayes" is an example?

A. Of the first five lamps I saw Mr. Sawyer run, only one I believe was a feeder lamp, the other four either had no feeding apparatus or the feeding device was defective and would not work, I don't remember which.

4733 33 R-d Q. Why are you able to say, as you do in answer to Q. 17 that you know that exhibit "Hayes carbon No. 2" has been in your possession for the last six years, and why are you unable to state that it has been in your possession longer? I wish to obtain by this question a brief statement by you of what you know of the history of this carbon.

A. These Sawyer lamp carbons were given to me by
Mr. Charles Stowell, an electrician who was employed in
the room where the Sawyer lamps were built. He had
4734 a number of these carbons and gave me these two. Mr.
Stowell left here six years ago, and I cannot remember
how long before leaving he gave them to me.

34 R-d Q. Does what you have said in your last answer apply to exhibit "Hayes carbon No. 1" as well as to exhibit "Hayes carbon No. 2?"

A. It does.

35 R-d Q. Did you or did you not frequently inspect
the Sawyer lamp both while it was burning and when
4735 cold during the time Mr. Sawyer was here at An-
sonia?

Objected to as leading.

A. I saw them both when burning and when cold very frequently.

36 R-d Q. Did Mr. Stowell at the time he gave you these carbons "Hayes carbons Nos. 1 and 2" inform you what carbons they were?

Objected to as calling for hearsay.

4736 A. He did.

Re-cross by Mr. Dyer.

37 x-Q. In stating that you saw carbons of the cross section of Hayes carbon No. 1, used in trying or running the Sawyer lamp, do you mean to make a distinction between pencils having the cross-section of

your carbon No. 1, and pencils having the cross-section of the fragment which is now in the exhibit "Sawyer lamp produced by Hayes?" 4737

A. I mean, that to the best of my knowledge and belief, of no greater diameter than exhibit No. 1.

38 x-Q. Do you recollect at this length of time that the carbons in any of the Sawyer lamps that you saw being tried had a smaller cross-section than that of the fragment in the exhibit "Sawyer lamp produced by Hayes?"

A. I recollect that the carbons I saw used were not 4738
much over one thirty-second of an inch in diameter.
The fragment in the lamp exhibit, so far as I can judge
without measurement, is nearly twice that diameter.

39 x-Q. Do you recollect measuring the cross-sections of the carbons at the time you saw them tried?

A. I have no recollection of making any measurements of them at that time. I remember measuring at different times carbons previous to their being treated by Mr. Sawyer.

40 x-Q. Have you preserved the data of those meas- 4739
urements, or can you state the exact results from
memory?

A. I did not preserve any data and can only say in a general way that they were about one thirty-second of an inch.

41 x-Q. How many of the Sawyer lamps built at the Wallace's are now in your possession?

A. I have none.

42 x-Q. Are there any preserved at the shops of 4740
Wallace & Sons?

A. Not that I am aware of.

43 x-Q. Do you recollect what became of them?

A. I know that there were a number of them about the shop and some of them were given away as a curiosity.

44 x-Q. Do you recollect when the room was cleared out in which those old lamps were, and the throwing

4741 of the remaining lamps and parts of lamps into the scrap heap?

A. I do not. I remember that when the electric work was moved up to the room under my charge there were a number of these lamps brought there and some little boxes holding different parts of the lamps.

45 x-Q. You have spoken of seeing the Sawyer lamps when running. Did you observe the feeding action?

A. I saw it used a great many times.

4742 46 x-Q. What was the operation of the feeding mechanism?

A. It operated to move the carbon pencil upward through the carbon jaws, so as to make a contact with the carbon rollers above it.

47 x-Q. Did you observe the action closely, so as to see where the pencil first began to give way?

A. The carbon pencil would sometimes break at the top, sometimes at the bottom, sometimes in the middle.

4743 48 x-Q. Does not the exhibit "Sawyer lamp produced by Hayes" show a considerable wearing or burning of one of the carbon rollers, while the carbon jaws below are intact?

A. The carbon roller appears to have been burned, while the jaws do not show any particular marks of having been burned.

49 x-Q. Is not the other carbon roller also partly worn away?

A. It is worn away, certainly.

4744 50 x-Q. What is this wearing away of these carbon rollers in the Exhibit probably due to?

A. To an imperfect contact with the carbon pencil, thereby forming a little arc and burning.

Re-direct by Mr. Bull.

51 R-d Q. State whether these feeder lamps were

4745

designed to have an imperfect contact between the burner and the rollers, and whether an arc was formed there when the lamps were in normal operation?

A. The contact was designed to be as perfect as possible and an arc was never formed when the lamps were in good working order.

Re-cross by Mr. Dyer.

52 R-x-Q. Did Mr. Sawyer tell you what his design 4746 was in this particular?

A. I do not remember that he did.

CHAS. H. HAYES.

Adjourned for supper.

7:30 P. M.

4747

Met pursuant to adjournment.

Jeremiah O'Brien called as a witness for the defendant, being duly sworn, testifies as follows.

1 Q. Please state your name, age, residence and occupation?

A. Jeremiah O'Brien; 48 years of age; Ansonia; grocer.

2 Q. Were you ever in the employ of Wallace & Sons of Ansonia, and if yea, please state what was 4748 the period of such employment?

A. I was seventeen years and ten months working for them. I went with them in August, 1869. I left in the year 1887.

3 Q. Did you, during your employment there, have anything to do with the manufacture of carbons for electric light, and if yea, please state what was the nature of your duties.

4749

A. Yes, sir. It was in 1877 or 1878, I cannot exactly tell, when I began working on carbons. I continued working on carbons until the time I left their employ. I commenced experimenting in them. I was making them until 1879, after that they were made by Mr. Burns and passed through my hands for examination.

4 Q. State, if you know, whether during the years 1877, 1878 and 1879 large numbers of carbons for electric lights were manufactured by Wallace & Sons for
4750 sale and were sold?

Objected to as leading.

A. There was none sold in 1877 as far as I can judge. There might be a small quantity of them sold in 1878. In 1879 there was a good many of them sold, the latter part of it. They sold some in the first part of 1879. I don't know how many.

5 Q. What did you have to do with the manufacture
4751 of carbons made or sold by Wallace & Sons during the years 1878 and 1879?

A. I was mixing the stuff and helping to make them.

6 Q. Did you have anything to do with pressing the material, after it was mixed, through the dies or nozzles to form them into wires or pencils?

Objected to as grossly leading.

A. Yes sir; I helped to press them through the
4752 nozzle.

7 Q. Did you have anything to do with baking them, and if yea, state what?

A. Yes, I put them in the fires after they were made.

8 Q. Of what materials were the carbons made for sale during the years 1878 and 1879?

4753

A. I shan't give the information what they were made of.

9 Q. Was it your practice during those years to subject the carbons after they were baked to subsequent treatment.

A. I believe not. I disremember whether we did in 1879 or not?

10 Q. I place in your hand Exhibit "Hayes Carbon No. 1." Please state whether you ever made carbons
of the size in cross-section of the carbon of that 4754
exhibit while in the employ of Wallace & Sons?

A. Yes sir.

11 Q. Please state when you first made carbons of that size, and give any circumstance in connection with making them which aids you in fixing the date?

A. In 1879, about the month of Mayor June; before the very hot weather came. I do not remember whether it was May or June, but it was one of those two months. 4755

12 Q. Do you remember the circumstances connected with the first order given you to make these carbons like Exhibit "Hayes carbon No. 1"?

A. To the best of my opinion Mr. Willian Wallace came to me and said we had to make a millimetre, and I asked him what a millimetre was. I did not know what it was at that time. He told me about the size of it, and I told him I did not think we could make them. He got Mr. Paul to make a nozzle for them and we made them afterwards. I had a job to make them too. 4756

13 Q. Do you know what was the size of the hole or die in that nozzle?

A. I disremember at that time what it was because I could not tell whether it was a 32nd or 64th he told me.

14 Q. Did you ever measure the hole in the nozzle?

4757 A. No, sir.

15 Q. Did you have any trouble in keeping these carbons straight while they were being baked?

A. Yes, sir; before they were baked.

16 Q. Was anybody accompanying Mr. Wallace at the time he gave you this order?

A. Not at the time he gave it to me there was not. There was a gentleman came with him a little time before or after that.

17 Q. Who was that gentleman?

4758 A. I did not know from Mr. Wallace; but I heard afterward that it was Mr. Sawyer. I don't know his first name.

18 Q. Is he the same Mr. Sawyer who was for some time working on electric lights at Wallace's shop in 1879?

A. To the best of my belief he was the same gentleman.

19 Q. Did you make carbons of other sizes than Hayes Carbon No. 1 during the Spring and Summer of 1879?

4759 A. Yes, sir.

20 Q. Of what other sizes?

A. Seven sixteenths was the most we made. I think we made $\frac{1}{4}$ inch and $\frac{1}{2}$ inch by $2\frac{1}{2}$ and 9 inches long; we made square $\frac{1}{2}$ inch too. The 7-16 were round. The $\frac{1}{4}$ inch were square.

21 Q. I place in your hand Hayes Carbon No. 2 which is about the same length but is of a little larger cross-section than Hayes Carbon No. 1. Did you ever make carbons of this size, and if yea, when?

4760 A. I did about the same time we commenced to make it; just after the other.

22 Q. Were you told by any one, and if yea, by whom, to what uses these small carbons were to be put?

A. Not to my knowledge. I may have been told then, but I disremember now.

23 Q. Did you make many or few of these carbons like Hayes Carbon No. 1? 4761

A. We made a great many of them.

24 Q. When?

A. In 1879, 1880, and different years after that.

Cross-examination by Mr. Dyer:

25 x-Q. At the time you left the employ of Wallace & Sons what were the sizes of the carbons that were being made? 4762

A. Round carbons $\frac{7}{16}$ of an inch in diameter and 12 inches long; $\frac{1}{2}$ inch (round) in diameter and 12 inches long; round $\frac{3}{8}$ of an inch and 12 inches long, and round $\frac{1}{4}$ in diameter and same length. These were the regular sizes when I left.

26 x-Q. Were other sizes made at that time, if so, what?

A. Yes, 5-16 of an inch diameter round and 12 inches long. There was a few of other smaller sizes, but they didn't amount to much. 4763

27 x-Q. When did you stop making carbons of the sizes of the exhibits "Hayes' carbons, Nos. 1 and 2"?

A. I disremember. It was a year or two, we might make a few of them up to the year before I left.

28 x-Q. What were the regular carbons made by Wallace & Sons made for while you were with them?

A. For lights, the majority of them, the regular sizes.

29 x-Q. What kind of lights? 4764

A. Electric lamps, street lights, hall lights, etc.

30 x-Q. Do you mean arc lights like the Brush and Thomson-Houston lamps.

A. Yes, sir.

31 x-Q. Round carbons 5-16 of an inch in diameter and 12 inches long were the smallest regular sizes made by the Wallaces at the time you left them; is that so?

A. That was about the smallest size.

4765 32 x-Q. Were these also used for arc lighting?

A. I do not know. I did not ask the question about them.

33 x-Q. How many of these 5-16 carbons compared to the larger sizes were made during the latter part of your employment?

A. Very few of them.

34 x-Q. What were the regular commercial sizes at that time, and how largely were they made?

4766 A. The regular ones were from the 7-16 up, and were made in thousands.

35 x-Q. What were the regular sizes of the carbons made by the Wallaces in 1879?

A. From a millimetre to a ½ inch.

36 x-Q. Which sizes were mostly made at that time?

A. To the best of my belief it was the 7-16.

37 x-Q. How many were made of the smaller sizes compared with the 7-16?

A. I could not give any estimate. We put from 300
4767 to 500 in each plate of them, but how many we made I could not tell.

38 x-Q. Were all these carbons made by the same process and out of the same materials?

A. I forget whether it was the same material in the millimetres as in the 7-16.

39 x-Q. Was the process of making the same?

A. Much the same process in them all.

40 x-Q. Please describe that process.

4768 Counsel for defendant instructs the witness that if this question calls for information which he regards as secret, he is instructed that he need not answer the question.

Counsel for complainant claims the right to cross-examine the witness without interference, upon matters brought out upon direct examination and material to the case, and gives notice that if the witness refuses

4769

to answer any proper question, whether instructed or not by defendant's counsel, he will move to strike the deposition from the record.

Counsel for defendant states that he has given the above instructions to the witness because it already appears upon the record that some part of the process of making the
carbon is a secret, and while he is perfectly 4770
willing to have everything appertaining to said carbons placed upon the record, he deems it proper to protect any secret information on the subject which this witness has. Counsel however instructs and urges the witness to answer the question as fully as he can without disclosing the secret information.

A. To the best of my knowledge, I don't know were
the millemetres made of the same material as the 7-16.
We mixed the material into a dough, put it into the 4771
press and pressed it out through the nozzle; the men took them then and baked them in the fire. That's all. They were ready for market then, after they were baked.

41 x-Q. What materials were mixed into a dough, and in what proportions?

Same instructions by defendant's counsel.

A. I object to answering that question.
42 x-Q. Do you know the materials and proportions 4772
that were used?

A. Yes.

43 x-Q. Then why do you refuse to state them?

A. Because it was supposed that Wallace & Sons made the best carbon in this country.

44 x-Q. Do you refuse to answer the question?

4773

A. Yes, sir.

Complainant's counsel gives notice of motion to strike out the deposition.

45 x-Q. Did the smaller carbons made by you or while you were at Wallace's look like the larger ones? Did the carbons look the same?

A. The little ones were a little lighter color than the larger ones.

46 x-Q. Would they all break on being bent?

4774 A. After they were baked, I should say they would.

47 x-Q. That is, they were not elastic carbons which could be bent? I mean, of course, the completed carbons?

A. After they were made you could bend them, but after they were baked you would break them by bending them.

48 x-Q. What do you mean by "after they were made?"

A. After they came through the nozzle, they were
4775 soft and I could bend them.

49 x-Q. They were not ready for use then?

A. No, sir.

50 x-Q. But after they were ready for use they were rigid and not flexible and elastic?

A. Yes, sir, they would break then.

51 x-Q. Were you connected in 1879 with the selling department of Wallace's?

A. No, sir.

52 x-Q. You don't know then what they sold and
4776 what they did not sell, do you?

A. No.

Re-direct by Mr. Bull:

53 R-d Q. Now, Mr. O'Brien I have no desire to ascertain any part of the process of making carbons

4777

which was practiced by you while in the employ of Wallace & Sons, but I understand that carbons of this sort have always been made by mixing some form of powdered carbon with some kind of carbonaceous liquid to the consistency of a putty and then baking the mass, after it has been fashioned, in the presence of a high degree of heat, and in closed vessels or crucibles. Will you please state whether this general process was employed by you without giving the exact
materials used or the proportions used if that is secret. 4778

Objected to as leading, also as indefinite and misleading

A. Yes, sir; that was the process used by me

54 R-d Q. In what lengths were the small carbons like Hayes 1 and 2 made?

A. First year, we made them either 9 or 10 inches long I disremember which of the two lengths, and those we made after 1879, were 12 inches long.

55 R-d Q. Have you in your possession, or are you 4779
able to produce, any of the original carbons made while you were in the employ of Wallace & Sons?

A. No, I mislaid them. I could not find them. I did have them.

56 R-d Q. Have you been requested by me to look for them, and have you looked?

A. Yes, sir.

57 R-d Q. You have stated that during the years 1878, 1879, carbons were made for sale and sold by the
Wallaces. What, if any, reason have you to believe 4780
that they were made for sale and sold at the time stated in your answer to Q. 4?

Counsel reads answer to question 4.

A. Thomas Wood told me to take them over to his office and he would ship them.

58 x-Q. Did you take them to his office pursuant to

4781 his instructions, and did you ever see them boxed for shipment?

A. I took them to his office according to instructions, but did not see them boxed for shipment.

Re-cross by Mr. DYER:

59 x-Q. After working on these small size carbons, did the Wallaces settle down on any definite size for
4782 these carbons, if so, what?

A. My belief is they did not.

60 x-Q. What was the diameter of these small carbons 12 inches long, which you say was the length made after 1879?

A. They called them all millimetres, whether they were ten or twelve inches long.

JEREMIAH O'BRIEN.

4783

HUGH A. BURNS called as a witness for defendant being first duly cautioned and sworn, testifies as follows:

1 Q. What is your name, age, residence and occupation?

A. Hugh A. Burns; age 32 years; Ansonia; carpenter.

4784 2 Q. Were you ever in the employ of Wallace & Sons of Ansonia, and if yea, please state the period of your employment and the nature of your work there?

A. Yes, sir; I was in the employ of Wallace & Sons, of Ansonia. I went there in 1868 or 1869, and left in 1887. I first went in the press department, remained in that until I went into the carbon department in 1878 and I continued in that department until the time I left.

4785

3 Q. Did you leave the employ of that firm at or about the time that Mr. Jeremiah O'Brien left?

A. Yes.

4 Q. What was the immediate cause of your leaving?

A. They sold the business of making carbons out.

5 Q. Had you and Mr. O'Brien been conducting the business of making carbons at the works of Wallace & Sons at your risk and under contract with said firm 4786
prior to the date when it was sold out?

A. We had, for about three months.

6 Q. What was the nature of your duties in the carbon department?

A. Helping to manufacture carbons.

7 Q. I wish an answer a little more specific. Did you have anything to do with mixing the materials, pressing them through the nozzles, as you call them, packing them in vessels or crucibles for baking, and subsequently baking them? 4787

A. Yes, sir; I did all those things.

8 Q. Do you know whether any carbons for electric lights were made for sale and sold during the years 1878 and 1879?

A. I know they were made to be sold, whether they sold them or not I could not say.

9 Q. What part of the period mentioned in my last question did they make electric light carbons to be sold?

A. In 1879. I should say from the early part of it. 4788

10 Q. In making the carbons referred to, did you in all cases mix some sort of a carbon in pulverized form with some kind of a carbonaceous liquid to the consistency of putty, then force this plastic material out through nozzles of the desired shape and size, then pack these rods or plates in crucibles or vessels and then place them in the fire and bake them?

Objected to as leading.

4789 A. I did.

11 Q. Did you subject any of the carbons so made to subsequent treatment, as, for instance, soaking them in a carbonaceous liquid and rebaking them, during the years 1878 and 1879 ?

Same objection.

A. Yes, sir.

12 Q. Did you so treat any of the carbons which
4790 were made to be sold or used, as distinguished from those which were made as experiments?

A. Nothing more than as experiments.

13 Q. I place in your hands Exhibit Hayes Carbon No. 1. Please state whether you ever made at Wallace's carbons of this size, and if yea, when did you first make them.

A. Yes sir; we made them of that size in the early part of 1879.

14 Q. I place in your hands Exhibit Hayes Carbon
4791 No. 2. Did you ever make carbons of this size when you were at the Wallace's, and if yea, when?

A. We made them something of that diameter I think about the same time we made the other; judging from the appearance of No. 1, I place that at a millimetre.

15 Q. Please state whether you did or did not make several different sizes of small carbons at about that same time?

A. Yes, sir; following right after that we made vari-
4792 ous different sizes.

16 Q. By what, if any, name were the carbons of the cross-section of Hayes' carbon No. 1 known in the shop?

A. Millimetre.

17 Q. Did you ever measure by a micrometer or otherwise the size of these smallest carbons which

4793

were called in the shop the millimetres before or after they were baked?

A. No, sir; not that I remember.

18 Q. Are you acquainted with the metric system, so as to know what part of an inch a millimetre is?

A. No, sir.

19 Q. It is true, is it not, that all carbons shrink during the process of baking them?

A. So far as my experience has been, they have.

20 Q. Were you acquainted with Mr. William E. 4794
Sawyer?

A. No, sir.

21 Q. Did you or did you not, at the time you made these small carbons, know to what use they, or any of them, were to be put?

A. Nothing more than I overhead that they were for a party coming from New York; whether he was there or not, I could not say.

Objected to as hearsay. 4795

22 Q. Did you hear at that time or subsequently to what use that party coming from New York was going to put those carbons?

Same objection.

A. Some time afterward I heard.

23 Q. What use was it?

Same objection.

A. Some kind of an oblong lamp arrangement work- 4796
ing on the incandescent principle, I believe.

24 Q. Who beside Mr. O'Brien and yourself were engaged in the actual work of making carbons during the years 1878 and 1879 at Wallace & Sons?

A. I could not say when the other parties came in, whether in the latter part of 1879 or not. We would

4797 have a man occasionally to help. We did the principal part of the work ourselves.

25 Q. What was the length of these small carbons about which you have testified?

A. They were about 9 or 10 inches in length.

Cross-examined by Mr. Dyer.

26 x-Q. Were you present during the giving of Mr. O'Brien's deposition?

4798 A. Yes, sir.

27 x-Q. Will you give the materials and proportions used in making the carbons at Wallace's?

A. The proportions have gone out of my mind now.

28 x-Q. What was the mixture employed at the time you left there, and how did it differ, if at all, from that employed in 1879?

A. The mixture we were using when we left there was coke and tar. In 1879 we had a great many different mixtures.

4799 29 x-Q. When did you settle down on the coke and tar mixture?

A. About 1884, I think.

30 x-Q. What was the mixture most generally used in 1879, if you recollect?

A. I could not exactly recall now.

31 x-Q. You referred to a note-book on your direct examination. Does that note-book give the mixtures or the sizes of the carbons?

4800 A. No, sir; it has nothing to do with the mixtures; it has a few different sizes in it made in the latter part of 1879.

32 x-Q. Will you let me look at the memoranda of those sizes as contained in your note-book?

A. Yes, sir, you can look at them if you wish.

33 x-Q. What are the smallest sizes referred to by

4801

you in your note-book as having been made in that part of 1879 covered by your note-book?

A. 1-16, 1-8 and 3-16.

34 x-Q. These figures are the diameters of round carbons, are they not?

A. Yes, sir.

35 x-Q. Does your note-book show the orders received in the carbon-making department during this period?

A. No, sir; it shows a part of them. 4802

36 x-Q. How many of these small carbons 3-16 and under does the note-book show were made during the latter part of 1879, and how many of the larger carbons?

A. I don't know.

Counsel for complainant and defendant jointly state that the witness has read from his note-book the legible entries giving the size and numbers of carbons ordered, and in some cases for whom ordered and that 4803 in adding the figures given by the witness, it appears that there were 91 carbons of 3-16 of an inch diameter and under, and 4,673 larger than 3-16 of an inch ordered, during the time covered by question x-Q 36; and also that the carbons of 3-16 and under were ordered in eleven lots, the largest lot being 24, and the larger carbons were ordered in 47 lots, the largest lot being 500.

4804

37 x-Q. What was your practice in mixing the materials for making carbons?

A. Hand practice.

38 x-Q. How large a batch did you mix at a time, and what were the implements employed?

A. About five pound weight. The implements were the brass pan and gas stove. The materials were put

4805 in the pan which was placed over the stove and were then mixed by hand.

39 x-Q. What was the consistency of the mass after mixture?

A. Putty fashion.

40 x-Q. As stiff as thick putty or thin putty?

A. I don't know what you mean by stiff putty; we made it not quite so stiff for the small sizes, and stiffer for the large sizes.

4806 41 x-Q. How long did it take you to mix a batch by hand?

A. 15 or 20 minutes.

42 x-Q. What was the heat of the gas stove employed for?

A. To consolidate the coke with the tar.

43 x-Q. That is, to make the tar more fluid and easier to mix with the coke?

A. The heat also had an effect on the coke as well as the tar.

4807 44 x-Q. Is it not a fact that your note book from which you read to counsel after 36 x-Q., covers, in the portion you read from, from October 1st, to December 31st, 1879?

A. To the best of my ability it does.

45 x-Q. I call your attention to the fragment of the carbon in Exhibit "Sawyer lamp produced by Hayes." When, if at all, did you make carbon pencils of this size?

4808 A. I have stated in a previous answer that we had made millimeters. This carbon I will not answer for. I don't know the size of it, or anything else about it.

46 x-Q. You don't recognize this carbon pencil in the Exhibit lamp as one of the sizes made by you while at Wallace's?

A. Yes, I should recognize it as being of about the size of some we made.

47 x-Q. How many sizes of dies or nozzles did you have for these small carbons?

4809

A. We had millimetre, 1-64 (I am giving them by the names we know them by); there is another small one, but I cannot recall the size of it; then 3-32 and from them to the sixteenths.

Re-direct by Mr. Bull:

48 R-d Q. Does the note book to which you have referred in your deposition contain a record of all the carbons ordered and furnished by you between October 1st and December 31st, 1879? 4810

A. No, sir.

49 R-d Q. Did you keep memoranda of the orders received by you prior to October 1st, 1879, and if yes, please state what has become of such memoranda?

A. I had some, but know nothing about what has become of them.

50 R-d Q. Did you look for them when you found the note book referred to?

A. No, sir; it was not necessary. If I had them 4811 they would be in this book.

51 x-Q. Are you then confident that such memoranda were not preserved?

A. I think they have been lost. If they had been preserved, they would have been in this book, and I am therefore confident they are lost.

52 x-Q. In your answer to x-Q 47 you have given the sizes of the dies or nozzles by which you made small carbons. Do you wish to be understood as saying that those were the only sizes which you used, or that they are the only sizes which you can now recall 4812 by name?

A. No, sir; I don't wish to be understood that they were the only sizes we used, but those are the ones I most conveniently recall.

HUGH A. BURNS.

Adjourned to February 13th, 1890, at 9 A. M.

4805 in the pan which was placed over the stove and were then mixed by hand.

39 x-Q. What was the consistency of the mass after mixture?

A. Putty fashion.

40 x-Q. As stiff as thick putty or thin putty?

A. I don't know what you mean by stiff putty; we made it not quite so stiff for the small sizes, and stiffer for the large sizes.

4806 41 x-Q. How long did it take you to mix a batch by hand?

A. 15 or 20 minutes.

42 x-Q. What was the heat of the gas stove employed for?

A. To consolidate the coke with the tar.

43 x-Q. That is, to make the tar more fluid and easier to mix with the coke?

A. The heat also had an effect on the coke as well as the tar.

4807 44 x-Q. Is it not a fact that your note book from which you read to counsel after 36 x-Q., covers, in the portion you read from, from October 1st, to December 31st, 1879?

A. To the best of my ability it does.

45 x-Q. I call your attention to the fragment of the carbon in Exhibit "Sawyer lamp produced by Hayes." When, if at all, did you make carbon pencils of this size?

4808 A. I have stated in a previous answer that we had made millimeters. This carbon I will not answer for. I don't know the size of it, or anything else about it.

46 x-Q. You don't recognize this carbon pencil in the Exhibit lamp as one of the sizes made by you while at Wallace's?

A. Yes, I should recognize it as being of about the size of some we made.

47 x-Q. How many sizes of dies or nozzles did you have for these small carbons?

A. We had millimetre, 1-64 (I am giving them by the names we know them by); there is another small one, but I cannot recall the size of it; then 3-32 and from them to the sixteenths. 4809

Re-direct by Mr. Bull:

48 R-d Q. Does the note book to which you have referred in your deposition contain a record of all the carbons ordered and furnished by you between October 1st and December 31st, 1879? 4810

A. No, sir.

49 R-d Q. Did you keep memoranda of the orders received by you prior to October 1st, 1879, and if yes, please state what has become of such memoranda?

A. I had some, but know nothing about what has become of them.

50 R-d Q. Did you look for them when you found the note book referred to?

A. No, sir; it was not necessary. If I had them 4811 they would be in this book.

51 x-Q. Are you then confident that such memoranda were not preserved?

A. I think they have been lost. If they had been preserved, they would have been in this book, and I am therefore confident they are lost.

52 x-Q. In your answer to x-Q 47 you have given the sizes of the dies or nozzles by which you made small carbons. Do you wish to be understood as saying that those were the only sizes which you used, or that they are the only sizes which you can now recall 4812 by name?

A. No, sir; I don't wish to be understood that they were the only sizes we used, but those are the ones I most conveniently recall.

HUGH A. BURNS.

Adjourned to February 13th, 1890, at 9 A. M.

4813

ANSONIA, February 13th, 1890.

Met pursuant to adjournment.

Present counsel as before.

JAMES H. PHALAN called as a witness for the defendant and being duly sworn, says:—

1 Q. Please state your name, age, residence and occupation?

A. James H. Phalan; 29 years of age; Ansonia; tool
4814 maker.

2 Q. Where are you now employed?

A. The Electricial Supply Company at Ansonia.

3 Q. Were you ever employed by Wallace and Sons of Ansonia?

A. Yes, sir.

4 Q. When did you enter and when did you leave the employ of that firm?

A. In 1871 I entered, and left in 1881.

5 Q. Were you acquainted with Mr. William E. Saw
4815 yer?

A. I was.

6 Q. What were your duties during the time that Mr. Sawyer was at work on electric lights at Wallaces?

A. Assisting him when he was at work at all times.

7 Q. Were you then constantly employed in the same room in which Sawyer was working during the whole time that he was at Wallace & Sons?

A. I was.

8 Q. Please state whether you did or did not fre-
4816 quently examine and inspect the various lamps which he then manufactured and run?

A. I did.

9 Q. Please state whether you did or did not frequently examine the carbon burners in these lamps before and after they were placed in the lamps and while they were illuminated?

A. I did.

4817

10 Q. Did you ever see Mr. Sawyer subject some of those carbon burners before they were placed in the lamp to any kind of treatment, and if yes, to what treatment?

A. I did see him put them in oil and boil them; they were heated by the electric current.

11 Q. And you mean, I presume, that this heating of the burners by the electric current caused the oil in which they were immersed to boil; is that it?

A. That's it. 4818

12 Q. I place in your hands Exhibit Hayes Carbon No. 1. Please examine this carbon, and state whether you have ever seen Mr. Sawyer employ in his incandescent lamps burners as small in cross-section as that carbon which you hold in your hand.

A. I have.

13 Q. Once, or more than once.

A. A number of times.

14 Q. Please state, as nearly as you can, when you
saw Mr. Sawyer first use burners of that size? 4819

A. It was in June, 1879.

15 Q. I place in your hands Exhibit Hayes Carbon No. 2, and Exhibit Sawyer Lamp produced by Hayes. Did you ever see Mr. Sawyer use in his lamp burners of the crosss-sections of the carbon of the Exhibit Hayes Carbon No. 2 and the broken burner of the exhibit lamp?

A. It seems as though I had seen them just like them.

16 Q. When did you see him use burners of those 4820
sizes?

A. During June or July, 1879.

17 Q. Did you ever see him use burners larger than either of these exhibits?

A. I have seen him use them as large as 1-16 in diameter.

18 Q. How long was Mr. Sawyer regularly employed

4821

at the shop of Wallace & Sons?

A. I think about two months.

19 Q. Are you confident that he was not regularly
working there later than the summer of 1879?

A. I know he was not.

20 x-Q. And were all these lamps concerning which
you have testified made and run while he was regu-
larly employed there?

A. They were.

21 Q. Did you ever observe what was the effect of
4822 the hydro-carbon treatment, which you say you saw
Mr. Sawyer practicing, on the color of the carbon?

A. I don't know that I noticed the difference be-
tween the colors before being treated and after treated.

22 Q. Did you ever see Mr. Sawyer have in his pos-
session carbon burners which were not straight?

A. I did.

23 Q. What shape were these?

A. Balloon-shaped. They were bent in that shape.
4823 A straight piece bent.

24 Q. Please sketch on this piece of paper the shape
of these carbons and their length, as well as you can?

A. I have done as requested.

Sketch made by witness offered in evidence
and marked Exhibit Phalan Sketch No. 1

25 Q. I have added the reference letters *a* and *b* to
the sketch you have made. What does the line *a* re-
present?

4824 A. The carbon burner.

26 Q. What do the letters *b b* represent?

A. The fastenings.

27 Q. Do you mean that they represent the clamps
by means of which the carbon burner was attached to
the leading-in wires?

A. I do.

28 Q. When did you first see carbon burners of this

4825

size and shape and by whom were they shown you?

A. In June or July 1879, by Mr. Sawyer.

29 Q. State whether Mr. Sawyer told you where
these were made?

A. I don't remember.

30 Q. Did he tell you whether they were made at
Wallace's or whether he brought them with him to
Wallaces?

A. I think he brought them. He never made a se-
cret of telling me anything about it, but I don't remem-
ber. 4826

31 Q. Did you first see these burners in lamps
attached to clamps and in position for burning, or be-
fore they were put in lamps?

A. I saw them before and after.

32 Q. Did he put any of these burners in lamps
while he was here and run them?

A. He did.

33 Q. State if you know whether these lamps were
on the feeder principle? I mean by that, whether they
had any mechanism for feeding the burner up to form a 4827
new contact when it was broken.

A. They did not; that is why they changed to
straight pencil carbons, so they could move it up.

34 Q. What remark did you make to Sawyer about
these balloon-shaped carbons when he first showed them
to you?

A. I said that looks like paper. He said it was
paper carbonized.

35 Q. What made you think that those burners
looked as if they were made of paper? 4828

A. Because they were so flexible.

36 Q. Anything else?

A. They seemed tough and did not seem to break as
they would if they were made from any other than
some such substance.

37 Q. Was there anything about their cross-section

4829 or width in two dimensions which suggested to your mind their probable origin?

A. I think we had pieces about 3 inches square and he cut them off with the shears.

38 Q. Were any of these already formed in shape when you first saw them.

A. They were not. We cut them off with shears, and bent them in shape.

39 Q. What was the cross-section of these burners
4830 after they were made?

A. I think about ⅛ of an inch.

40 Q. What was their cross-section in the other direction?

A. I think they were about seven thousandths of an inch in the other dimensions.

41 Q. How do you estimate that they were 7/1000 of an inch?

A. I put my micrometer on a sheet of paper just now, judging they were about the same thickness.

4831 42 Q. Am I right in understanding that your recollection is that they were about the thickness of the sheet of paper on which is contained Phalan's sketch No. 1, which is the sheet you measured a moment ago with your micrometer?

A. I think they were about 2-1000 of an inch larger than that sheet of writing paper. That sheet is 4-1000 of an inch thick.

43 Q. That would make the thickness of the burners referred to about 6-1,000 of an inch, would it not?

4832 A. It would.

44 Q. Did you ever see Mr. Sawyer make or use any lamps having straight pencils not acting on the feeder principle, that is, having permanent contacts at both ends of the burner?

A. I did, I remember that experiment distinctly because I thought the rolls did not make good contact.

45 Q. Do you remember whether he used in those

4833 lamps burners of the cross-section of "Hayes Carbon No. 1"?

A. I do remember using them as an experiment.

Cross-examined by Mr. Dyer.

46 x-Q. What had been your duties before you assisted Mr. Sawyer?

A. Assisting Mr. Stowell in the same room.

47 x-Q. What was the character of assistance you gave Mr. Sawyer? 4834

A. Getting the lamps ready and getting ready all experiments with him.

48 x-Q. Did you work on the making of lamps yourself?

A. No, I didn't make any.

49 x-Q. Do you know what kind of a lamp was made for Mr. Sawyer at Wallace's factory?

A. This kind of incandescent lamp that I am looking at here. 4835

(Witness points to Exhibit Sawyer Lamp produced by Hayes).

50 x-Q. Did you know William Sharp as connected with the work on the Sawyer lamps at Wallace's?

A. I did.

51 x-Q. What did he do?

A. Put the mechanical parts of the lamps together.

52 x-Q. Was he the principal mechanic doing work on these lamps? 4836

A. He was.

53 x-Q. You have spoken of other kinds of lamp-structures than the feeder lamp before you, that is, lamps without the feeding mechanism. How many of these latter lamps did Mr. Sawyer have at the Wallace's?

A. I don't remember any certain number because they did not use them there except for experiments.

4837 They were like the feeder lamp except the feeding tube and mechanism were omitted and the upper rollers were replaced by a clamp.

54 x-Q. During the two months that Mr. Sawyer was working at the Wallaces' what were his habits and how regular was he in his attendance at the shop?

A. He generally came there at 8 o'clock and stayed till 12; and from 2 until 4. He appeared all right in the shop; he appeared very gentlemanly in all his at-
4838 tendance to his business.

55 x-Q. How many experiments were made with the lamps not having the feeding mechanism?

A. I don't know just how many. There were very few.

56 x-Q. The work then was principally upon the feeder lamp?

A. It was. That was the work we stopped on.

57 x-Q. Please explain how the feeding mechanism worked in these feeder lamps and what caused it to
4839 work?

A. By pressing on a button there was connection through the dynamo and magnets while the lamp was in circuit, to make and break by making the current go through the magnet and that would feed up the carbon.

58 x-Q. Did you observe closely the appearance of the carbon while burning and the point where the rupture usually took place?

A. I did.

4840 59 x-Q. What was the usual point of rupture of the carbon-burner?

A. When the rolls would not press close enough together it would form an arc between the rolls and the carbon, and burn off the carbon and burn a flat place on the rolls.

60 x-Q. Was this a usual or an unusual action with such of these lamps as were tried at Wallace's?

4841

A. It would be on account of defective mechanism.

61 x-Q. Did it occur frequently?

A. Yes, sir, it did; that was no fault of the lamp; they had too much current. If it were properly arranged it would not burn off.

62 x-Q. The Exhibit "Sawyer Lamp produced by Hayes," which is before you, shows marked evidence of this arc action, does it not?

A. It does exactly.

63 x-Q. I call your attention to the fragment of the 4842
carbon burner still in this exhibit lamp. Was this the usual or an unusual size for the burner in trying these lamps?

A. I think it is the usual size we used.

64 x-Q. How extensively did you try larger or smaller sizes of burner in lamps of this kind?

A. We found this size to be the most economical to use, as the others took too much current—the larger ones—and the smaller ones would burn off too 4843
quickly.

65 x-Q. Then in your experiments or trials the larger and smaller burners were discarded for the size, a fragment of which is in this exhibit?

A. They were.

66 x-Q. Please measure the diameter of the fragment of the burner in the exhibit "Sawyer lamp produced by Hayes" with the micrometer, which you held in your hand, and state what its diameter is.

A. I find it by measurement 50x1000 of an inch.

67 x-Q. Do you know what was the electrical resist- 4844
ance of the carbon burner in this lamp?

A. I do not. Mr. Stowell measured it while I was there, but I don't remember what he said it was.

68 x-Q. When Mr. Sawyer was in Ansonia you discovered that he was a man of intemperate habits, did you not?

A. I did.

4845

69 x-Q. Under what circumstances did he leave the Wallace's, so far as you know?

A. I don't know.

70 x-Q. Had he finished the work ?

A. It seemed to me that he had, so far as I know.

71 x-Q. Was the work continued after he left ?

A. It was not.

72 x-Q. Why not ?

A. I don't know.

4846 JAMES H. PHALAN.

Ansonia, February 13, 1890.

Present as before.

Thomas James Wood called as a witness for the defendant after being duly sworn testifies as follows :

1 Q. What is your name, age, residence and occu-
4847 pation ?

A. Thomas James Wood ; 40 ; Ansonia, Conn.; Superintendent.

2 Q. Please state where you are now employed, and how long you have been employed there.

A. Wallace & Sons ; between 24 and 25 years.

3 Q. Did you have anything to do with the shipment of carbons for electric lights made by Wallace & Sons during the years 1877, 1878 and 1879 ?

A. I did.

4848 4 Q. Please state what.

A. Well, I gave the shipping clerk at times orders where to ship the goods, at other times I shipped them myself.

5 Q. Were the shipping books in which shipments of this class of goods were entered, under your supervision or control during the period referred to by me in Q. 3 ?

4849

A. They were.

6 Q. Are some of the entries therein in your own handwriting.

A. They are.

7 Q. When did you begin to sell and ship carbons for electric lights ?

A. To the best of my knowledge and belief in 1876.

8 Q. Did you continue to sell and ship such carbons during the years 1877, 1878 and 1879 ?

A. Yes. 4850

9 Q. Have you at my request refreshed your memory on this point by referring to your shipping book ?

A. I have.

10 Q. State, if you know, whether the carbons for electric lights sold and delivered by Wallace & Sons prior to the year 1880 were or were not subjected to treatment after they were baked, by immersion in a carbonaceous fluid and by then rebaking ?

A. They were not. 4851

11 Q. Were you in charge as superintendent of this department of the Wallace works during the years 1876, 1877, 1878, 1879 ?

A. I was.

Cross-examined by Mr. Dyer :

12 x-Q How large a business did the Wallaces do in the manufacture of carbons ?

A. During the time we were in the business we thought we were doing a very large business. 4852

13 x-Q. For what purpose were these carbons used ?

A. For electric lighting. .

14 x-Q. What kind of electric lighting ?

A. That I could not tell. I supposed for both kinds.

15 x-Q. When did they stop making carbons ?

A. I think it was either in 1886 or 1887. I would not be positive as to that date.

4853

16 x-Q. At the time they sold out their business in carbons, for what character of lighting were their carbons used?

A. At that time I did not have charge of the work, but I supposed they were used for arc lighting.

17 x-Q. Do you mean to say that their carbons were ever used to your knowledge for any other kind of lighting than arc lighting, except experimentally.

A. That I don't know anything about.

4854 18 x-Q. Do you recollect shipping or ordering the shipment before 1880 of any carbons not suited for arc lighting?

A. I cannot remember.

THOMAS JAMES WOOD.

Feb. 26, 1890.

Parties meet pursuant to agreement.

4855 Presest, RICH'D N. DYER, Esq., for complainant and J. EDGAR BULL, Esq. for defendant.

CHARLES STOWELL, a witness produced on behalf of defendant, being duly sworn and interrogated by Mr. Bull, testified as follows:

1 Q. What is your name, age, residence and occupation.?

A. Charles Stowell. I am 61 years of age; I reside
4856 at Boston, Mass., and am an electrician.

2 Q. Were you ever in the employ of the firm of Wallace & Sons, of Ausonia, Conn.?

A. Yes.

3 Q. When did your employment by th firm begin and when did it end?

A. Began July 8, 1875. Ended July 1, 1885.

4 Q. Please state in general terms what experience you had in the art of lighting by electricity, prior to July 8, 1875?

4857

A. I was in the employ of Mr. Moses G. Farmer of Boston for about seven years previous to going into Wallace's employ. Mr. Farmer was conducting experiments in incandescent and arc electric lighting more or less all the time I was with him. I was his assistant during this time, and was actively engaged in all his experiments. I may add that I was well acquainted with Mr. Farmer for about fourteen years before I went into his employ. From the year 1852 until I went into his
employ I was in his laboratory very frequently, and I 4858
assisted him gratuitously in a considerable number of his experiments. He was experimenting in incandescent electric lights at this time. Indeed, I am informed during the winter of 1858-59 Mr. Farmer illuminated his parlors, with incandescent electrics lamps with platinum burners or illuminants. This was a matter of common knowledge, and descriptions of this use were published in the newspapers at the time.

5 Q. What was the nature of your duties while you
were in the employ of Wallace & Sons? 4859

A. I was their electrician.

6 Q. Were you acquainted with Mr. Wm. E. Sawyer, who was at one time, i. e., during the early part of the year 1879, at work at their shops?

A. I was.

7 Q. What were your duties during the time that Mr. Sawyer was working at Wallace & Sons?

A. I was at that time in general charge of the electrical room at their works, and all of Mr. Sawyer's work 4860
was done in that room, which was 100 feet long by 40 feet wide. I was, therefore, in the same room and saw every day much that he did. I was instructed by Mr. Wallace to give him all the assistance in my power, and I therefore assisted him.

8 Q. Please produce, if you can, some of the original carbons prepared or used by Mr. Sawyer while he was at Wallace & Sons?

A. I now produce six carbons in a little wooden

4861 trough or box, which I took with me from Ansonia when I left in 1885. These carbons I know have not been out of my possession since that time. I do not think they have been out of this box since 1885 until about a week ago when Mr. Curtis called upon me, and I showed them to him.

9 Q. What makes you think that these carbons are the original ones prepared or used by Mr. Sawyer?

A. I know they were because I got them at the time.

4862 10 Q. Have they been in your possession ever since?

A. Yes.

11 Q. Can you state by examining these carbons whether or not they have all been electrically treated?

A. I don't know whether all six have been treated or not. (Here witness examines the two carbons in glass tubes.) Referring to the two in the glass tubes, I should not like to say that I have seen those two treated.

12 Q. Please state whether you ever saw Mr. Saw-
4863 yer subjecting such carbons as these to electrical treatment?

A. Yes, many of them.

13 Q. What, if any effect did this electrical treatment have upon the appearance of the carbons?

A. It made the surface silvery, smooth, like depositing metal.

14 Q. Judging from the appearance of these carbons in glass tubes, please state whether they have such silvery appearance, and whether in your judgment they
4864 have been treated?

A. Yes.

The two carbons in glass tubes produced by this witness are offered in evidence and marked Defendant's Exhibits, "Two Sawyer carbons produced by Stowell."

1865

15 Q. Are the other four carbons produced by you, but not offered in evidence, of substantially the same length and diameter and external appearance as those now in evidence, marked "Two Sawyer carbons produced by Stowell"?

A. Yes, except that one is a little shorter.

16 Q. Did you ever see Mr. Sawyer employ, in the incandescent lamps used by him while at Ansonia, carbon illuminants of the cross-section of the Exhibits "Two Sawyer carbons produced by Stowell"? 4866

A. Yes.

17 Q. Once, or more than once?

A. Many times.

18 Q. Mr. Hayes has testified to the fact that Sawyer brought with him to Ansonia from New York several incandescent lamps, some of which had no feeding mechanism. If you have any memorandum concerning these lamps, please produce it?

A. I find in my memorandum book, May 1, 1879, the following entry: 4867

"May 1, 1879.

"With Sawyer lamps—we had 5 of them at once in series, and they all worked well on Siemen's 800 revolutions. One single lamp was run 3 hours. In the evening we ran the 5 several times."

19 Q. In this entry it is recorded that "one single lamp was run 3 hours." What do you remember about that single lamp?

A. That Mr. Sawyer wanted the other four stopped 4868 so that that one could be run to show the feeding. It was the only one that had the feeding in it.

20 Q. Am I right in understanding from this that four of these five lamps had their illuminants clamped at each end permanently, and had no device in them by means of which the carbon could be fed up when broken?

Objected to as leading.

4869 A. They were not permanently clamped, and could have had the carbon feed if they had had the feeding mechanism.

21 Q. Do you mean that the jaws which held the ends of the carbon were pressed upon the carbon by means of a spring?

Same objection.

A. Yes.

22 Q. Referring to Exhibit "Two Sawyer carbons
4870 produced by Stowell," please state (if you have measured them or either of them) what is the diameter of these carbons?

A. I measured one of them this morning at the request of Mr. Bull, and found it was 31-1,000 of an inch.

23 Q. Do you remember giving any carbons like these to Mr. Hayes before you left Ansonia?

A. I do not remember it. I may have.

24 Q. Would you be surprised to learn that you had done so?

4871 A. No, sir.

Cross-examined by Mr. Dyer.

25 x-Q. How long did Mr. Sawyer stay at Ansonia as you recollect?

A. I cannot tell. I have no record of it.

26 x-Q. Does your note book to which you have referred, contain any entries showing the results of the tests of the Sawyer lamps at Wallace's. If so what are they?

4872 A. I find in my note book the following entries on this subject:

"May 2, 1879. All the forenoon we ran one of the new Sawyer lamps with Siemens machine, 400 revolutions, 3½ hours. Broke once and Mr. Sawyer fed it up.

P. M. started at 1:40 and had good light at start, Ran till 5:30, single lamp, with evening, 10:30, ran till 10:30 when one lamp ruined."

4873

"Aug. 27, 1879. Page 92. Sawyer's lamps, two of them with good light gave a deflection of 83 degrees. Resistance in circuit 1.18 ohms 83 tan. 8.144 x5.7=46.42 vebers 46.42x1.18 ohms 54.752 volts."

"Sept. 11, 1879. Started the first Sawyer Lamp made here at 9:5 A. M. with Little Joker, wire on armature and field. One of the 5 armatures made months ago to try the lamps that Mr. Sawyer brought up at a speed of 1,280 measured revolutions. We got a steady good light. At 10:50 had to stop the machine, too hot. 4874
Cooled it, took the armature out. Set it running again at 11:25, at 11:45 had to stop running, too hot. Afternoon, set the English Siemens machine upon it at 3:10 with a speed of only 461 (c d.), good steady light.

Had to stop in 15 minutes because the coils of large wire I put in for resistance got so hot as to smoke."

"Sept. 12, 1879. Changed the Siemens to slower speed, 330 revolutions.

Began at 8:20, and in 15 minutes carbon burnt off, 4875
fed it up and continued; ran till 12 o'clock, time 3:40. Started at 1 o'clock, stopped machine half an hour, Wm. Wallace ordered it. Started again at 3:20; at 4:30 carbon burnt off, tried to feed it up and the rollers would not work. All the time to-day 7:40

4:40

12:20

twelve hours and twenty minutes.

Sept. 12, 1879. Rollers would not turn but Mr. M. 4876
succeeded in feeding up the carbon and began to run at 4:45 same lamp that he thought he could not make feed up.

Whole run up to Sept. 13, 13 hours and 35 minutes, Sept. 13, 1879. Started at 7:5. The light was much brighter at the start (machine cold). Had to stop during the afternoon half an hour on account of the machine so hot. Whole time to Satur

4877 day night 23 hours, five minutes. Deflection of Gal. of Siemen's machine at start 83½

Sept 15th, 1879. Started the Sawyer lamp this morning and in a few minutes the carbon burnt off. Mr. Myers fed up the carbon and started at 11.5; burnt off again at 11.40. Mr. M. fed it up and re-lit; run till 12.55 minutes; making in all 24 hours run with 4 breaks. This P. M. ran 8 of the Sawyer lamps with the English Siemens at a speed of 800 revolutions; at 4.50 started the lamp again—that has run 24 hours. Ran
4878 till 6 o'clock; now 25h. 10 minutes.

Sept. 17th, 1879. Started and was 25 minutes in starting because it was heating too hot; put a short resistance in without the lamp and heated the machine hot, then put the current on the lamp and in about 2 minutes the carbon burnt off. Mr. Myers fed it again; only one of the carbon rollers would turn; one had been burned Sept. 12th at 4.30; made out to get started at 8.25. Had to stop twice to-day so only 8 hours run, making in all 33h. 10 minutes.

4879 Sept. 18th, 1879. Started the same Sawyer lamp, run only a short time; tried starting it twice; did not burn off as before when the machine and lamp were cold.

Sept. 19th, 1879. Started the Sawyer lamp at 10.35 to be run as long as it will run. Mr. T. Wallace—at 11 the carbon burnt off; Mr. T. Wallace saw it. Mr. Myers fed it up again after several attempts, and it went on; 11.25 burnt off again near the top of the carbon. Mr. M. fed it up. At 11.50 burnt off again. Mr. M.
4880 fed it and it burned in all this P. M. 1.55. Upper rollers were cracked and burned flat. Lower jaws were burned out so they did not grip the carbon. In all about 2¾ inches of carbon, and the globe badly smoked; 36h. 20 minutes.

Sept. 19th, 1879. Sawyer Lamp started Sept. 11th and has burned in all 36h. 30 minutes. Has burned

off 8 times and consumed in all 2¾ inches of carbon. 4881

Condition of lamp: Upper rollers cracked and burned flat on one side. Lower carbon jaws burned out so they did not grip the carbon. Globe badly smoked. Reason of stopping bad contact of the jaws so the carbon would not heat.

Copy of the above given to Mr. T. Wallace, Sept. 19th, 1879."

[Witness continues:]

There were a great many experiments tried of which I made no record at all. I was never called upon to 4882
make any record, and I kept this record for my own personal use.

27 x-Q. Did Mr. Thomas Wallace give you instructions about the test under date September 19th?

A. The test is several days. He said at that time, run it till you burn it out. It had then been running several days.

28 x-Q. Why did he want it run until it burnt out?

A. I don't know. 4883

29 x-Q. Am I correct in understanding that the last entry under date of Sept. 19, 1879, is a resumé of the tests with the Sawyer lamp?

A. Yes.

30 x-Q. Did you ever measure the resistance of these Sawyer lamps?

A. Yes, sir. I am positive that I have, but I have no record of it.

31 x-Q. Was the measurement made while the burner was cold or while it was at incandescence? 4884

A. Both.

32 x-Q. What was the resistance under each condition?

A. I don't remember.

33 x-Q. The Sawyer lamp was one of low resistance intended to be run into series with others on the same circuit, was it not?

4885 Objected to as indefinite.

A. I don't know what the intention was. It was run there in series.

Re-direct by Mr. Bull.

34 x-Q. Do you find that your note book contains any records of tests of lamps made or used by Mr. Sawyer while he was at Ansonia, except the memo-
4886 randa under date of May 2d, 1879?

A. Yes.

35 Q. What other memoranda concerning tests of the lamps made or used by Mr. Sawyer while there do you find in this note book?

A. I find those in September 11, and subsequent dates.

36 Q. Was Mr. Sawyer present when those tests in September, 1879, were made?

A. Not all the time. He might have been there part
4887 of the time.

37 Q. Do you find in either of these memoranda anything which indicates that Mr. Sawyer was present while those September tests were being made?

A. No, I do not.

38 Q. Had or had not Mr. Sawyer made many tests with his lamps at Ansonia, prior to September, 1879, at which you were present?

A. Yes.

39 Q. Was it any part of your duties to keep records
4888 of these tests and did you in fact keep any records except that in your note under date of May 2nd, 1879?

A. It was not my duty to keep them. I did keep what I have in my note book.

40 Q. Does your note book contain a record of all the tests made with the Sawyer lamps after Mr. Sawyer left Ansonia?

A. No, sir.

4889

41 Q. Is or is it not true that all the September memoranda are records of tests with the "first Sawyer lamp made at Ansonia," except that part of the entry under date of September 15th, 1879 in the following words: "this P. M. ran 8 of the Sawyer lamps with the English Siemens at a speed of 800 revolutions?"

Objected to as leading.

A. As I understand the question I should answer, 4890
yes. It all has reference to the first lamp made at Ansonia. I started it and kept it separate from the rest

42 x-Q. Do you find in your note book any record of the total life of any other lamp than this?

A. No.

43 x-Q. What did you mean by the entry "first Sawyer lamp made here" and how many such lamps were made in a single lot?

The latter part of the question objected to as not called out by the cross-examination. 4891

A. I meant the first of one hundred that were made in one lot.

Re-cross by Mr. Dyer:

44 R-x-Q. Do you recollect any tests with the Sawyer lamps at Ansonia made later than those recorded in your note book under date of September 19, 1879?

A. I think I remember sixteen or seventeen being tried at one time later than September 19, 1879. I 4892
don't remember the exact number.

45 R-x-Q. This was before Mr. Myers left Ansonia, was it?

A. Yes.

46 R-x-Q. Have you any records of life tests in any other Sawyer lamp than the one which you tested in September, 1879?

A. No.

47 R-x-Q. Were life tests made of the other lamps?

A. I don't remember.

CHARLES STOWELL.

4893

Counsel for complainant offers in evidence pages 54 to 104 inclusive of the book referred to in the cross-examination of the witness Albon Man, entitled "Electric Lighting by Incandescence," by Wm. Ed. Sawyer, and the same is marked Complainant's Exhibit Extract from Sawyer's Book on Electric Lighting.

Counsel for Complainant also offers in evidence the following newspaper publications
4894 made by the said Wm. Ed. Sawyer, some of
which are referred to on the cross-examination of the witness.

1. Letter to the "New York Sun" of December 22, 1879, and the same is marked Complainant's Exhibit Sawyer's "Sun" Letter of Dec. 22, 1879.

2. Letter to the "N. Y. World" of Dec. 24, 1879, and the same is marked Complain-
4895 ant's Exhibit, Sawyer's "World" Letter of
Dec. 24, 1879.

3. Letter to the "N. Y. Herald" of Dec. 24, 1879, and the same is marked Complainant's Exhibit Sawyer's "Herald" Letter of Dec. 24, 1879.

4. Letter to "N. Y. Sun" of Jan. 5, 1880, the same is marked Complainant's Exhibit
4896 Sawyer's "Sun" Letter of Jan. 5, 1880.

5. Letter to the "N. Y. Herald" of Jan. 5, 1880, and the same is marked Complainant's Exhibit Sawyer's "Herald" Letter of Jan. 5, 1880.

4897

6. Letter to the "N. Y. Herald" of Jan. 6, 1880, and the same is marked Complainant's Exhibit Sawyer's "Herald" Letter of Jan. 6, 1880.

7. Interview published in the "N. Y. Tribune" for Jan. 2, 1880, and the same is marked Complainant's Exhibit Sawyer's "Tribune" Interview of Jan. 2, 1880.

4898

8. Letter to the "N. Y. Tribune" of March 26, 1880, and the same is marked Complainant's Exhibit Sawyer's "Tribune" letter of March 26, 1880.

9. Letter to the "N. Y. Herald" of August 13, 1880, and the same is marked Complain-
ant's Exhibit Sawyers "Herald" letter of
August 13, 1880. 4899

Defendant's counsel waives proof of publication at the dates given of the foregoing exhibits; such exhibits to be printed as a part of complainant's record.

Adjourned to January 23, at 11 A.M.

4900

Edison Electric Light Co. v. United States Electric Lighting Co.

Volume III

Defendant's Proofs and Depositions

Circuit Court of the United States.

SOUTHERN DISTRICT OF NEW YORK.

IN EQUITY No. 3445.

THE EDISON ELECTRIC LIGHT COMPANY

vs.

THE UNITED STATES ELECTRIC LIGHTING COMPANY.

ON LETTERS PATENT No. 223,898.

Vol. III.

Defendant's Proofs—Depositions.

DUNCAN, CURTIS & PAGE,
Defendant's Solicitors.

SAMUEL A. DUNCAN,
EDMUND WETMORE,
THOMAS B. KERR,
LEONARD E. CURTIS,
Of Counsel for Defendant.

EATON & LEWIS,
Complainant's Solicitors.

621.326

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Defendant's Exhibits:—Printed.

Compl't's Exhibits:—Offered in Evidence.

Complainant's Exhibits:—Printed.

Stipulations.

Miscellaneous.

U. S. Circuit Court,

FOR THE SOUTHERN DISTRICT OF NEW YORK.

4906

THE EDISON ELECTRIC LIGHT COMPANY,
Complainant,

against

THE UNITED STATES ELECTRIC LIGHTING COMPANY,
Defendant.

In Equity. No. 3445. On Letters Patent No. 223,898.

4907

NEW YORK, January 20th, 1890.

Met pursuant to agreement of counsel at the office of Duncan, Curtis & Page, 120 Broadway.

Present: Messrs. CLARENCE A. SEWARD and RICHARD N. DYER, counsel for complainant.

SAMUEL A. DUNCAN and LEONARD E. CURTIS, for defendant.

HENRY MORTON, a witness produced on behalf of defendant, being duly sworn and examined by Mr. Duncan, testifies as follows:— 4908

1 Q. What is your name, age, residence and occupation?

A. Henry Morton; I am fifty-three years of age and reside in Hoboken, N. J. I am the President of the Stevens Institute of Technology.

4909

2 Q. What is your acquaintance with the laws of electrical science and with the practical application of these laws to the useful arts, and particularly to the art of electric lighting?

A For the last thirty years a large part of my time has been devoted to the study of electric laws and phenomena, and to their application and utilization in connection with the arts. During all this time I have had a great variety of electric apparatus in my possession or charge, and have been constantly engaged in
4910 using the same. Long before electric lighting came into general commercial use I was familiar with the electric generators and electric lamps then employed for purposes of illustration or experiment; and when the invention of the Gramme dynamo-electric machine and others gave a commercial feature to the subject, I was engaged in testing and comparing the various new forms of electric lamps and dynamo machines for my own information and for that of those interested in the construction or use of such machines and lamps. I
4911 believe that I have in this connection operated and tested all the principal varieties of dynamo machines and lamps now in use.

3 Q. What experience have you had in the examination of patents and inventions, and in testifying as an expert in controversies involving patented inventions?

A During the last twenty years the large part of my time not occupied by my official duties has been employed in the examination of patents and of patented ma-
4912 chinery and processes, and in giving testimony in suits on such patents in the Circuit Courts of the United States. I have been actively engaged in more than a hundred such cases.

4 Q. Will you explain briefly the principle on which "*incandescent*" electric lamps operate, and how they differ in principle of operation from what are known as "*arc*" lamps?

4913

A Whenever an electric current is caused to traverse a medium (either solid, liquid or gaseous) some resistance is offered to its passage and this resistance develops heat, the amount of heat developed being proportional to the resistance and also to the square of the current passing, in other words, the total heat produced will be measured by the product of the resistance and the square of the current strength. If the current remains, or is kept, constant in various cases,
then the heat will be proportional to the resistance. 4914
If the resistance is constant then the heat will vary with the square of the current strength.

To maintain a constant current through an increased resistance will require an increase of propulsive action which is called "electro-motive force" (E.M.F.) or "pressure;" and so also, to increase the current strength through the same resistance will require an increase in the propulsive action or E.M.F.

These actions are exactly analogous to those of water
flowing in pipes. 4915

Suppose we have a certain "head" or pressure of water (corresponding to E.M.F., or electro-motive force, in electricity) in a reservoir, and a pipe leading from it through which the water flows out. If we increase the resistance of this pipe by contracting its diameter, then to keep up the same rate or flow through it we must increase the "head" or pressure of the water in the reservoir.

In like manner, if we wish to increase the rate of flow, or current strength, in a given pipe, we must in-
crease the head or pressure of the reservoir corres- 4916
pondingly.

From the above considerations it appears that if we cause a sufficient current to flow through a sufficiently high resistance we can develop any amount of heat in the resisting medium or conductor. For example we may render the conductor so hot as to emit light, or become "incandescent."

4917

Such an incandescent conductor so arranged that the light developed can be used as such, is an incandescent electric lamp.

In the operation of such incandescent lamps certain general principles are involved which have been familiar the last fifty years or more.

Thus, in the first place, all electric conductors vary in resistance directly as their lengths, and inversely as their cross-sections. This is similar to the action in water-pipes. The longer a pipe is the more will it re-
4918 sist the flow of water through it; and the larger it is the less it will resist such flow.

Again, different materials offer different amounts of resistance to the flow of electricity, even when they have the same length and cross-section. This we speak of as "specific resistance."

The following table expresses the *relative* resistances of a number of familiar materials.

Silver	1.000
Copper (annealed)	1.063
Iron "	6.460
Platinum	6.022
German silver	13.920
Mercury	62.730
Carbon rods for electric lamps,	2326. to 3702.

4919

From what has been above stated it is evident that to produce an incandescent electric lamp we must select some substance of a high specific resistance, and give it a small cross-section in proportion to its length in order
4920 to secure sufficient resistance within a small area to develop so intense a heat as will produce an adequate light; for it must be remembered that a given amount of heat diffused through a large mass or over a large surface would fail to bring the large mass or surface up to a luminous intensity, while the same amount of heat concentrated in a small mass or on a small surface will render the same brilliantly luminous.

4921

This can be illustrated by holding a fine platinum wire in the flame of an alcohol lamp when it will at once become brilliantly luminous; while a thick wire of the same substance similarly placed will not even reach a red heat.

Dr. Wollaston demonstrated the same thing nearly a century ago. When Sir Humphrey Davy was exhibiting his enormous battery of two thousand plates at the Royal Institution, and among other things heating
with it many feet of large platinum wire, Wollaston 4922
met him one day and taking out of his pocket a tiny bottle battery with a microscopically fine platinum wire between its poles showed him that this fine wire could be heated to whiteness by the insignificant current of this pocket battery because its energy was concentrated upon so minute a quantity of matter.

This smallness of mass and surface in the incandescent conductor is also demanded by another consideration when the incandescent lamp is intended to replace
a source of light of moderate intensity like a gas burn- 4923
er or like domestic lamp. A large mass or surface heated to such vivid incandescence as is requisite for the economical production of light by electricity would develop an immense volume or intensity of light amounting to many hundred candle power at the least.

From the above general explanations it will, I think, be easy to understand that the principles on which incandescent electric lamps of all sorts operate, are the following: 4924

The production of intense heat, and consequently light, by causing an electric current to traverse a conductor of high resistance and small size, the high resistance being secured by the combination of the following elements in the conductor: 1st., length; 2nd., small section; 3rd., high specific resistance. All of these elements act in the same direction or to produce the same result, namely, to secure a high total resis-

4925 tance in a conductor of sufficiently small mass, and thus develop intense heat and light on the passage of an adequate current.

In the "arc" lamp the conditions are entirely different. In this case two conductors (electrodes or poles) are brought in contact while connected with an electric generator so that a current is established between them, and are then separated to a short distance.
4926 Under these circumstances the current will tear off and in part vaporize particles from the separated ends or poles, and hurl them across the intervening space of air. This violent disruptive and projecting action develops heat and light in the ends of the poles and in the vapor and flying particles between them, but none of this heat and light is due to any resistance of the conductors themselves.

Any resistance, however slight, in the conductors is simply an occasion of loss and inconvenience, and
4927 in an arc lamp conductors which have absolutely no resistance would be ideally perfect.

The entire effect is developed in the space between the poles and in actions at their surfaces, and in fact depends mainly even there, not on resistance properly so-called, but on what is known as "counter-electromotive force."

However this may be, the resistance of the conductors contributes nothing to the desired result of heat and light.

4928 In the incandescent lamp, however, as we have seen, the resistance of the conductor itself is the vital element, and a conductor with little or no resistance would be absoluted useless and incapable of operation in an incandescent lamp.

5 Q. What difference, if any, does this difference in principle of operation of the two kinds of electric lamps make necessary in the matter of the electric con-

ductivity (or, using the reciprocal term, in the electrical resistance) of the carbon or other material used in the lamp for producing the light? 4929

A. In the case of the arc lamp the resistance of the carbon or other conductor cannot be too low, and all efforts have been directed to the end of securing the lowest possible resistance consistent with the avoidance of drawbacks from other effects. Thus the carbons are made as large as they can be without ob- 4930
structing the light coming from their ends by their own bulk. They are also generally plated with copper as thick as can be used without interfering with the operation of the arc as it melts and burns. This is done for the purpose of increasing the conductivity of the carbon pencil.

On the other hand, the conductor of an incandescent lamp is always made with as high resistance as is consistent with the electro-motive force (E. M. F.) available for the operation of the lamp, and with the ca- 4931
pacity to construct the conductor of small section, while giving it adequate mechanical strength and durability.

Thus, in the electric lamps first made by Geissler and others over twenty years ago for use in mines, for night fishing and for throat illumination, in which the enormous E. M. F. of Ruhmkorff induction coils was utilized, the incandescent conductor was a thread of rarified gas enclosed in a fine glass tube wound into a long spiral, so as, by its length and small cross section, to 4932
offer a correspondingly high resistance to the electric current.

In like manner, King and other early inventors used, and directed the use of, very thin sheets of platinum or very thin rods of carbon, their available E. M. F. being such as could be obtained from galvanic batteries or magneto-electric machines of about equal efficiency.

4933

To-day, when lamps are to be run in "series," and where therefore the E. M. F. available for each lamp is relatively low, the resistance of the carbon conductors is made of from less than one to six or eight "ohms" or units of resistance, while where the lamps are used in "parallel," and much higher E. M. F. is therefore available for each lamp, the resistance of the carbon conductors is from fifty ohms upward, usually one hundred ohms or more.

4934

6 Q. How long has it been known that this difference in the electrical resistance of the conductors used in the two sorts of electric lamps, "arc" and "incandescent," was an essential feature for their successful operation in each case?

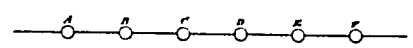
A. This was known from the time of the earliest experiments in either direction. When Sir H. Davy made his first experiments with the arc light he recognized the fact that the source of light was located between
4935 the poles and in no way derived from the resistance of the poles or the conductors themselves; and the earliest experimenters who heated wires or other conductors to incandescence by the electric current, recognized that this effect was due to the resistance which those conductors offered to the passage of the current. This was fully set forth in various patents and publications of an early date, as for example in the description of the experiments of Mr. Children in the Philosophical Transactions, June 15, 1815, Vol. 15, Part I, pp. 363-
4936 374.

7 Q. Please explain the terms "in series" and "in multiple arc," or "in parallel," as applied to the arrangement of incandescent lamps or other devices for converting electric currents into useful work?

A. When a number of electric lamps or other translating devices, such as telegraph instruments, or

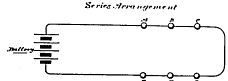
4937

electric engines, are connected so that the current runs into one and after passing through it then goes out of the first and into the second, and so on, we call the arrangement one "in series." This would be represented by the diagram below: A, B, C, D, E, F, being the electric lamps or other devices, and the lines between them the connecting wires.



4938 In place of being all arranged in a straight line the devices and connecting wires may be arranged in a loop coming back nearly to the starting point, and the battery or other electric generator can then be so placed as to close the circuit, as thus:

Series Arrangement



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In the former arrangement the battery may be at either end, and the earth may be used to complete the circuit. In the latter case, the circuit is a metallic one. In either case, this will be a "series arrangement."

If, on the other hand, the current flows out by a conductor from which branches are taken off to each lamp or other device, so that no current runs from one lamp to another, then we call this "multiple-arc" or 4940 "parallel" arrangement.

Thus, in the diagrams below, let A, B, C, D, E, F, be electric lamps or the like, and P P' the outgoing conductor; the vertical lines are the connections to the various lamps. This would be an arrangement in "multiple arc" or "parallel," and the return from each

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lamp might go to the earth, as shown in Diagram 1, or to a return wire N. N' connected to the other pole of the battery, as shown in Diagram 2.

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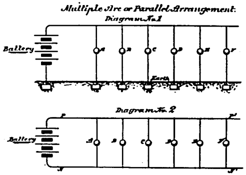


8 Q. Will you please explain the meaning of the
4943 term "ohm" as used in the electric arts?

A. The term "ohm" means, in a general way, the unit of electrical resistance, just as pound means the unit of weight. The exact value of the ohm or electric unit has been slightly changed from time to time and is not yet absolutely settled, but these variations are unimportant in connection with the present subject. In a general way, an idea of an ohm may be given by stating that it is about the resistance offered by a copper wire one-sixteenth of an inch in diameter
4944 and 378 feet long; or of a platinum wire of the same size and about 70 feet long; or of a rod of arc-light carbon of the same size and about one inch long.

9 Q. Also please explain the term "volt" as applied to an electric current?

A. A "volt" is the unit of electro-motive force (E. M. F.) or propelling power, analogous to "head" or "pressure" in a flowing liquid, under which the elec-

4945
tric current is made to flow or which causes it to flow. To give a general idea of the value of this unit we may say that it is about the propulsive power of one couple of Daniel's battery, otherwise known as the sulphate of copper battery. Again, to drive the electric current across the air space or arc of an ordinary Brush arc lamp, such as is in common use for street lighting, requires the pressure of 50 volts; and to operate the ordinary lamps of the Edison Co. about 100 4946
to 110 volts pressure is employed.

10 Q. In like manner please explain the term "ampere," and the term "watt"?

A. The term "ampere" expresses the unit of strength of an electric current or the rate of flow, and is exactly analogous to the expression of a gallon per second as the unit of flow of water.

Thus when we say that a certain current is one of ten amperes, we express exactly the same idea as when 4947
we say that the flow of water in a certain pipe is ten gallons per second. In the latter case the time is expressed, in the former it is implied. Thus, if I say that the current in a certain incandescent lamp is a current of one ampere, I mean that one unit quantity of electricity (called a coulomb) flows through that lamp each second. This term may be, and is, correctly defined in many other ways, as, for example, by saying that it is the current which one "volt" of E. M. F. will produce through the resistance of one "ohm;" but the definition which I have selected and given 4948
above is to my mind much the most direct and easy of apprehension.

A notion of the practical magnitude of this unit will be gained by considering that an ordinary Brush arc-light uses a current of about 10 amperes, and the ordinary Edison incandescent lamp uses a current of about three-quarters of one ampere.

4949 The "watt" is the unit of rate of electric work and represents the work done when a current of one ampere passes through the resistance of one ohm.

It is entirely analogous to the mechanical unit of rate of mechanical work called a horse-power. A horse-power is the rate of doing work expressed by saying that a horse-power represents 33,000 pounds lifted or moved against the resistance offered by gravity, one foot every minute. In this last case also, the time element is expressed in the definition of horse-
4950 power, but it is equally involved in the definition of the "watt," because the term "ampere" itself expresses a rate or amount passing in a unit of time

The two definitions would coincide exactly in form if we said, as we might with entire accuracy, that a "watt" was the rate of doing work realized by the passage of one Coulomb of electricity through or against the resistance of one "ohm" each second.

The "watt" is equal to $\frac{1}{746}$ of a horse-power. In other words, 746 "watts," acting in an ideally perfect
4951 electric engine, would develop work at the rate of one horse-power in the same; or one horse-power applied to the pulley of an ideally perfect dynamo, would develop an electric current whose rate of work would be 746 "watts."

To give an idea of this quantity, we may say that in the arc of an ordinary Brush lamp, electric work is done at the rate of about 500 "watts," and in an ordinary Edison incandescent lamp at the rate of about 60 "watts."

4952

11 Q. The terms "translator" and "translating device" are frequently used in connection with the electric arts. What do these terms mean?

A. They refer to any devices or arrangements by which the energy of electric currents is transformed into or caused to develop some other form of energy,

4953

such as mechanical motion as in an electric engine or telegraph instrument, sound as in a telephone, heat as in fuses for blasting, or light as in electric lamps of all sorts.

12 Q. What do you understand to be the meaning of the terms "economy" or "efficiency" as used in connection with the application of the electric current to the performance of useful work? 4954

A. The ratio between the entire energy expended by the current throughout the whole system and that portion of said energy employed in the production of the useful work under consideration. For example, suppose an electric circuit consisting of an electric generator such as a battery or a dynamo and a number of electric engines used to operate sewing machines. If the total electric energy of the entire circuit was 100 and that developed in the electric engines was 80, I should say that economy or efficiency of such an ar- 4955
rangement was 80 per cent.

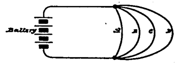
13 Q. What are the general laws relating to the distribution of the electric current among the different parts of the circuit, including the "translators" and the conductors that carry the current from the generator to the translators?

A. In the first place we have the general law known as Ohm's law, that the current strength in any circuit or part of a circuit will be proportional to the electro- 4956
motive force present in that circuit or part of a circuit and inversely proportional to the resistance in the same circuit or part of a circuit. This law is expressed by the equation $C=\frac{E}{R}$, C standing for current strength (expressed in "amperes"), E for electromotive force (expressed in "volts"), and R for resistance (expressed in "ohms").

4957 This law is a perfectly natural or antecedently probable one, and analogous to what would happen with water running in pipes.

Thus the current of water would be greater in a pipe as the pressure forcing it through was increased and less as the resistance was made greater, as, for example, by diminishing the section or bore of the pipe.

4958 Next to this Ohm's law, we have that of "derived circuits," as when a conductor is divided into two or more branches which reunite again, as thus:

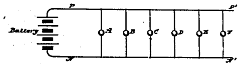


In such a case the current will divide itself among
4959 all the "derived" circuits or branches so that the amount in each will be inversely proportional to the resistance. Thus suppose that the resistance of the circuits A, B, C, D, are as 1:2:3:4: then will the currents be as 1: ½: ⅓: ¼. This action again is analogous to the flow of water in pipes.

If we had four pipes branching from a main whose resistances caused by their cross-sections were as 1:2:3:4 (the smallest cross-section expressing the highest resistance), then clearly the flow in the smallest pipe
4960 whose resistance was 4 times that of the largest would be ¼ and so on.

Third, we have the law of the combined resistance of parallel circuits, as when we have two or more parallel circuits and wish to compare the resistance of the system with that of one of its branches.

Thus suppose we have two large parallel conductors whose resistance is so low that we need not take it 4961
into account, and connect them first by one and then by more parallel cross branches, thus:



4962

Let P P' and N N' be the large main conductors connected with the poles of the battery, and suppose that a cross circuit A having a resistance of 10 ohms is alone placed between the mains. The resistance between the mains will then clearly be 10 ohms. Now suppose that another cross circuit B, having also 10 ohms resistance, is added; then the current will have two paths in place of one to travel by, and as a consequence the resistance to its getting across will only 4963
be half as much as before.

This is exactly parallel to the action of water in pipes similarly arranged. Suppose the battery was replaced by a pump, and the mains P P' and N N' by large pipes; then that only one small cross pipe A, was connected between the mains, the water would be greatly resisted in getting from one main to the other, P P' being an outgoing and N P' a return main.

If now two pipes, A and B, were connected across between the mains, the obstruction or resistance to the 4964
flow of the water would be only half as great; with three cross connections it would be only one-third as great, with four pipes one-fourth, and with five pipes one-fifth.

In other words, if the parallel cross circuits are all alike we have only to divide the resistance of one by the number of cross circuits to find the resistance presented by the whole system of such cross circuits.

4965

When the cross resistances are not equal to each other, we cannot combine them by so simple a method, but must find the result of two by dividing their product by their sum, or of more than two by dividing their continued product by the sum of their partial products. In the present case, however, we need not consider any examples requiring this treatment.

Lastly, as far as the present subject is concerned, we
4966 have what is known as "Joule's law," which is, in effect
—That the amount of heat or like energy developed in any circuit in a given time is proportional to the square of the current strength multiplied by the resistance.

This may be expressed by the formula $W=C^2R$; W standing for the "energy" or "work" developed, and C and R standing as before for the "current strength" and "resistance."

If we consider the time as other than unity, then
4967 we have $W=C^2\times R\times t$.

It follows from this law of Joule that, if the current is constant, the work or energy, such as light or heat, developed in a given circuit or part of a circuit is directly proportional to the resistance of such circuit or part of a circuit. This was practically illustrated as long ago as in the experiments of Davy, who among other things prepared a chain of alternate links of silver and platinum. When a current was passed through this chain the platinum links, by reason of
4968 their high resistance, were heated to brilliant incandescence, while the silver ones were not visibly affected.

14 Q. How long have these several laws of Joule, Ohm and the others been known, and are they applicable to all electric circuits irrespective of the particular kinds of translating devices used in the circuits?

Joule's law was, I believe, announced by its author

4969

in the Philosophical Magazine, Vol. 19, p. 260, in 1841.

Ohm's law was first announced by its author in 1826, in a journal entitled Schweiger Journal, Vol. 46, p. 137. It was also discussed in the same journal for 1827, Vol. 49, p. 1; also, in a book entitled "Die Galvanische Kette," published in 1827, the law was again stated and discussed by its author.

The other laws, I cannot date so exactly, but I find them fully discussed in the work entitled "Traité de l'Electricite," by A. De la Rive, Paris, 1856, Vol. 2, p.
19, *et seq.*, and in the English translation of the same 4970
work published in London the same year, Vol. 2, p. 77, *et seq.*

These laws are all applicable to all electrical circuits, irrespective of the translating devices used in the same, provided proper account is taken of the "counter electro-motive forces" where such are developed. These, however, do not exist in incandescent electric lamps.

15 Q. Please state whether the definition which you
have heretofore given, of the term "incandescent elec- 4971
tric lamp," includes the apparatus known as the Geissler tubes?

A. It does include such varieties of this apparatus as were constructed and used to give light of such a quality and intensity as to be available for purposes of illumination, either local or general. For example, a Geissler tube arranged for use as a miner's lamp, or one to be employed in sub-aqueous lighting for night fishing, or, again, one used to illuminate the interior of the
throat for surgical treatment, would be, as I under- 4972
stand the term, properly included within the general definition of "incandescent electric lamps."

16 Q. Please describe generally the construction and operation of the Geissler tube, when organized for use as an incandescent lamp?

4973 A. A Geissler tube in all cases consists of a tube or vessel made entirely of glass and highly exhausted, by the use of such an apparatus as the Geissler or the Sprengel air pump, and having conducting wires fused into and through the glass walls of the structure at its opposite ends, or at points more or less distant from each other. These tubes sometime enclose other and smaller tubes or vessels, more or less complex in their arrangement according to the special effects it is desired to produce, but often the apparatus is a simple
4974 glass tube, exhausted as above stated and provided with the leading-in wires sealed into the glass wall.

When an electric current of high electro-motive force (such as would be obtained from induction coils, or from galvanic batteries consisting of a great number of cells arranged in series) is passed through such tubes or vessels, it develops light by the resistance which it encounters in passing through the trace of gas left in the tube in the process of exhaustion. This gas
4975 constitutes a high-resistance conductor between the two wires by which the current enters and leaves the tube; and the light produced is of different colors, according to the character of the gas present.

When it is desired to make the light brilliant, so that the tube may be used as a lamp for purposes of illumination, a portion of the tube through which the current passes is highly constricted, so that the current is concentrated into a narrow line and experiences along this line a relatively high resistance. This nar-
4976 row portion of the tube also frequently is coiled so as to still further concentrate the luminous action within a small space, and thus increase the local intensity of the light.

As a further means of increasing the luminous power of such Geissler tubes, the glass of which the concentrated portion is made is frequently selected of a material possessing the property of fluorescence, which

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is a power of converting the blue and violet or faintly luminous rays of light developed by the incandescent gas into green or yellow rays, whose relative luminous intensity is much greater. But this last arrangement or use of a fluorescent substance is not always adopted. Many of the tubes consist merely of clear glass containing ordinary atmospheric air, or carbonic acid gas in a highly attenuated condition.

Such a Geissler tube as those which I have referred to as being used for miners' lamps and the like, might 4978
be correctly described as consisting of a thin incandescent thread or line of rarefied gas developing light by incandescence, brought about by its opposing high resistance to the passage through it of the electric current; such high resistance being due both to its high specific resistance, and to its small cross-section.

It follows that, so far as concerns the principle of operation involved in the use of a slender thread or line of highly resisting material to produce light by incandescence, I find it developed in the case of such 4979
Geissler tubes as I have alluded to in the same way as it is in those incandescent lamps in which a thin strip, thread or wire of solid material is employed, such as carbon, platinum, irridium, etc.

17 Q. How does the interior of these Geissler tube lamps compare as to their cross-section with the cross-section of the burners of the carbon incandescent lamps now in commercial use?

A. There is no great difference in cross-section between the light-giving body in the case of the Geissler 4980
tube lamps and the commercial incandescent electric lamps having carbon burners. Although as a general rule the cross-section of the bore or interior of the Geissler tube is larger than the carbon conductor of the ordinary commercial electric lamp, yet in some Geissler tubes, used as lamps, the cross-section of the

4981 illuminating part is smaller than in some of the carbon incandescent electric lamps; in many cases, in fact, the portion of the Geissler tube used for the production of light has a *capillary* bore, or, in other words, is made of what we know as capillary glass tubing, such as is employed in the manufacture of thermometers.

18 Q. Have these Geissler tubes constructed for the purpose of illumination been made and sold commercially; and, if so, for how long to your knowledge, and
4982 to what extent?

A. They have been, for at least twenty years. Previous to my coming on to Hoboken from Philadelphia, in 1870, I myself had bought and used a considerable number of Geissler tubes of various sorts, including some of those designed and used for purposes of illumination, and I purchased many more within the next year or two, and of these a large number are still in my possession.

At the time I mention, these tubes were a regular
4983 article of commerce, being manufactured not only by their first constructor, Geissler, but by several others, and they have been so ever since.

19 Q. Do you find the use for Geissler tubes as electric lamps for producing light for the purposes you have indicated referred to in publications or patents prior to 1879?

A. I do, in numerous patents and publications prior to the date mentioned, and among others in the follow-
4984 ing: English patents to Morris, Weare & Monckton, No. 188 of 1862, and No. 1,516 of 1862; English patent to Mironde No. 1,651 of 1866, English patent to Cook, No. 2,717 of 1874; English patent to De Sussex & Brasseur No. 2,194 of 1877; proceeding of the Royal Society of London of March 29, 1860, Vol. 10, page 432; Du Moncel's Notice sur l'Appareil d'Induction de Ruhm-

korff, published at Paris in 1867, page 390 to 399, and in the Inductorium or Induction Coil, by Henry M. Wood, published by John Churchill & Sons at London in 1868, page 101. 4985

20 Q. How does the total resistance per inch of length of one of these Geissler-tube lamps, compare with the resistance of an ordinary carbon lamp?

A. The resistance of the Geissler tube is vastly greater than that of the carbon conductor of the ord- 4986
inary incandescent lamp, on account of the extremely high specific resistance of the gaseous medium that serves as the incandescent conductor in the Geissler tube.

21 Q. Will you produce one or more of these Geissler-tube lamps which you have had in your possession for a long time?

A. I herewith produce two of these tubes, one being designed as a lamp for sub-aqueous illumination for 4987
fishing, and the other as a surgical lamp for illuminating the throat.

These two have been in my possession since 1871.

This surgical lamp consists of two comparatively large end bulbs which are united by a much smaller tube, which at its middle part is drawn down so as to be very fine, and this slender part is coiled upon itself. By this construction, the high resistance is concentrated at the coiled or spiral part, which thus becomes the principal point of illumination. This part of the lamp 4988
is enclosed in an outer glass tube for the purpose of protection. One of the end bulbs of this lamp was accidentally broken off a short time since.

The sporting lamp which I have produced is constructed substantially like other lamps which were made and sold twenty years or so ago as "miners' lamps" and so advertised. In this lamp, also, the two

4989 end bulbs are connected by a narrow tube of great length which is coiled in a spiral, and this central light-giving portion is for the purpose of protection enclosed in a glass tube, and this tube is again enclosed in a larger one capped with brass, converting it into a sort of a lantern.

Defendant's counsel offers in evidence the two lamps now produced, and the same are marked respectively Defendant's Exhibit
4990 "Geissler-tube surgical lamp" and Defendant's Exhibit "Geissler-tube fishing lamp."

22 Q. The term "burner," I believe, is frequently applied to the carbon and also to the platinum which is used as the source of the light in carbon and platinum incandescent lamps. Would it be equally proper to apply the term "burner" to the line or thread of gas which constitutes the source of light in the Geis-
4991 sler-tube lamps?

A. It would be equally proper. The only appropriateness of the term *burner* in any of these uses is the fact that the object to which it is applied is the source from which the light radiates, in which respect it resembles the burner of an ordinary lamp or gas fixture.

23 Q. Have you other Geissler tubes which have been in your possession for a long time and which you
4992 can produce?

A. I have, and herewith produce six tubes out of a very large collection which has been in my possession for many years. The identical tubes produced, or tubes just like them, have been in my possession for at least twenty years.

The first of these tubes is known as a spectrum tube, consisting of two elongated end bulbs, with a very

small-bore tube connecting them: the bore of this tube 1993
is capillary like that of an ordinary thermometer. The effect of thus narrowing the tube in its middle part is to produce a much higher resistance in that part, and, as a consequence, the illumination in the narrow portion is much greater than in the two end parts where the gases are of larger volume.

The next tube which I produce is a lamp, the illuminating part of which consists of a tube drawn down
so as to have a very small bore and then coiled into a 4994
spiral and this spiral arranged in the form of a rosette. By this arrangement, a great length of the fine line or thread of the attenuated gas contained in the tube is concentrated into a comparatively small space and consequently a relatively high illumination is obtained.

The next tube which I produce has two large end bulbs connected by a small-bore tube which is arranged in a spiral form. For purposes of experiment in the lecture room, the middle part of this tube is surround-
ed by a glass envelope into which various liquids may 4995
be introduced.

The next tube which I produce is the well known tube called Gassiot's cascade.

The next tube which I produce has the two end bulbs connected by a small tube which is expanded at several points into a spherical form. In this tube the highest light is developed at the narrower parts.

The next tube which I produce has the two end bulbs connected by a long thin tube, the middle port-
ion of which is coiled into a spiral 4996

Defendant's counsel offers in evidence these six Geissler tubes last produced by witness, and the same are marked respectively Defendant's Exhibit, Geissler tubes, "No. 1," "No. 2," "No. 3." "No. 4." "No. 5," "No. 6."

4997

24 Q. Of what material are the conducting wires which carry the current into the Geissler-tube lamps?

A. Where they pass through the glass they are always made of platinum, but their prolongations within the tube are generally made of aluminium.

25 Q. Why are the conducting wires made of platinum at that point where they pass through the glass?

A. Because platinum is the only conductor which
4998 can be successfully united directly to the glass walls of a highly exhausted vessel so as to form a permanently perfect air-tight joint. This union is effected by fusing the glass directly upon the wire.

26 Q. How long has it been known in the arts that platinum is the best material to use as a conductor for carrying a current of electricity through the glass walls of an exhausted vessel?

A. For at least fifty years, and without doubt much
4999 longer. It was well known in the time of Davy who flourished in the opening years of this century. I find in Faraday's "Chemical Manipulation" for the instruction of students in chemistry, published at Philadelphia by Cary & Lea, in 1831, on p. 539, the following directions in regard to the fusing of such wires into glass vessels of various kinds, with a statement as to the reasons why platinum is the best metal to be used for this purpose. This is stated by Faraday not as anything novel, but merely by way of instructing stu-
5000 dents in regard to well-known laboratory practices. Section 1201, page 539, is as follows:

"1201. It is of great importance in many experiments "to be able to seal a metallic wire into glass, so that "the latter shall close around it and adhere to it in a "manner perfectly air-tight and sound. The detonat-"ing eudiometer tubes (994), and the tubes for the "collection of gas (1046, 1049) during the voltaic de-

"composition of liquid substances in solution, are 5001
"common instances of their valuable application. "Platinum is the only metal which answers well for "this purpose, and fortunately it is that which, in "consequence of its chemical relations, is the most "useful in such situations. The superiority of plati-"num depends upon its infusibility at the temperatures "required to work the glass, and on the close agree-"ment of glass and platinum in the rate of their ex-"pansion and contraction by changes of temperature. 5002
"Other metals, as iron, differ much from glass, and "when wires of these are enclosed in the most secure "manner they either separate when cold from the "glass by contraction, destroying the continuity all "around them, or, if that does not take place, they re-"tain the glass in the immediate neighborhood in such "state of tension that very slight accidents cause it to "fly, and cracks to proceed from the wire into the glass "in several directions. This rarely happens with "platinum enclosed in the thickest glass, if the junc- 5003
"tion has been good and the glass well softened."

Then follow minute instructions to the student for performing the necessary operations of sealing the wires in so as to make an air-tight joint.

27 Q. You have indicated that the walls of the Geissler-tube lamps are made "entirely of glass." What do you mean by this and why are these instruments so made?

A. I mean that the interior of the tube is every- 5004
where separated from the air by the material glass, except so far as the two platinum conductors limit the universality of this statement. In other words, wherever during the construction of the tube a joint has been made between one part of the enclosing walls and another, this joint has been effected by fusing together the edges in contact, so as to produce a continuous

5005 glass envelope. The reason for this is, that by such an arrangement or structure absolute security against leakage can be obtained, and, therefore, the perfection of the vacuum once secured, it can be indefinitly maintained.

28 Q. How high a vacuum is attained in the manufacture of these Geissler tubes?

A. It varies in different tubes, according to the object which it is desired to secure. In some of them it
5006 is the highest vacuum obtainable; but in most it is somewhat less than that usually secured in the bulbs of the common incandescent electric lamps, but much higher, I think, than can be obtained with an ordinary mechanical air-pump.

29 Q. Do you understand that the object in reducing the diameter of the Geissler tube, when the same was to be used as a lamp, was to increase its illuminating power; and if so, how would this special con-
5007 struction contribute to that result?

A. The object of reducing the diameter was unquestionably to increase the illuminating power, and it did so by concentrating the action by which the electric energy was transformed into light, into a small space, so that an intense development of the latter form of energy was obtained.

In other words, in this case, as in all other like transformations of electrical energy, the *amount* of the new energy developed was proportional to the
5008 current and to the resistance experienced, and the intensity of the effect depended upon the smallness of the area within which a given amount of energy was transformed or developed.

All these conditions were secured by reducing the diameter of the tube, just as they are secured in the case of the ordinary incandescent lamp by reducing the diameter of its carbon conductor or burner.

5009

30 Q. Have you examined the British patent No. 10,919, granted to Edward A. King, in the year 1845?

A. I have examined this patent.

31 Q. What to you find to be the instruction of the King patent as to the degree of vacuum to be used in the second form of lamp which it describes—that is, the lamp which is provided with a *carbon* burner?

A. As perfect a vacuum as the state of the art at the time the apparatus was to be constructed would enable one to secure. In this connection the patent says: 5010

> "When carbon is used, it becomes neces-
> "sary, on account of the affinity this sub-
> "stance has for oxygen at high temperatures,
> "to exclude from it air and moisture. *To ac-*
> "*complish this in the most perfect manner* it
> "should be enclosed in a Tooricelien (Torri-
> "cellian) vacuum."

At the date of this patent a Torricellian vacuum was the most perfect vacuum known; and even to-day, if produced with proper care and skill, it would be an ex- 5011
tremely efficient vacuum; but I should understand that anyone endeavoring to carry out the process of the King patent, at any date after the invention of the Geissler or the Sprengel pump (which are improved apparatuses for creating vacuums, invented some time after the year 1845), would consider himself as called upon to use, and that he naturally would use, one of these more convenient forms of apparatus in the construction of the lamp. The essential instruction of the patent is that the constructor is to secure "*the most per-* 5012
fect" vacuum, the particular method of obtaining that result manifestly being a matter of minor importance; and consequently one working under the patent should employ the best means known to himself at the time for carrying out the essential directions of the patent.

32 Q. Would it be practicable to use the Geissler

5013 pump or the Sprengel pump for producing the vacuum in that form of carbon lamp which is shown in King's second sheet of drawings, being the lamp in which the lower end of the exhausted bulb or tube is closed with mercury, and if so, how?

A. It would be, by the simple and well-known expedient of attaching a tubulure or small branch tube to one side of the elongated bulb, *a*, shown in Figure 2. If no other change than this was made, then the lower end of the long barometer tube would be immersed in a
5014 vessel of mercury, and, the air from within being exhausted through the lateral tubulure by means of the Sprengel or the Geissler pump, the mercury would rise in the barometer tube to a height corresponding to the atmospheric pressure. The branch would then be sealed off from the pump.

33 Q. State whether, in your opinion, it would have involved invention, at any time after the development of the Sprengel pump or the Geissler pump, to have
5015 made use of these pumps, in the manner you have just indicated, for creating the vacuum in the construction of a lamp under the King patent?

A. Manifestly not: because what was done here would have been done substantially whenever a Sprengel or a Geissler pump was used with a mercurial gauge attached to indicate the progress of the exhaustion. Moreover, these pumps have been the means usually employed, ever since they were invented, for exhausting Geissler tubes and Crookes radiometers, and for
5016 like purposes.

34 Q. The King patent, after describing the construction of the carbon lamp illustrated on sheet two of the drawings, in which the lower end of the vacuum tube is closed by mercury, says:

"When the apparatus is *suitably sealed* "(italics mine) it may be applied to submarine

5017

"lighting, and also the illumination of places "where it is necessary to guard against in- "flammation of highly combustible or explo- "sive compounds, as in powder magazines, "mines, &c."

What do you understand to be the modified construction of lamps thus referred to?

A. A lamp like that shown in the drawings on sheet two, except that the lower end of the bulb would be sealed off from the barometer tube, after exhaustion, 5018
in the usual manner of sealing off one part of a tube from another, that is, by fusion of the glass by use of the blow pipe. Of course, in order that this should be done effectually the wire *n* as well as the wire *d* would have to be made of platinum.

If the vacuum were to be produced by the use of a Geissler or a Sprengel pump, there would be manifestly no necessity for having the long barometer tube in the first instance; but the bulb *a* would be constructed alone and after the upper wire *d* had been 5019
sealed into the bulb and the lower wire *n* attached to its clamp, the lower end of the bulb would be drawn out and sealed off, being fused directly on to the wire *n* in the same manner in which the upper wire *d* is sealed into the glass; and the removal of the air would be effected by the use of the pump through a side tubulure such as I have above referred to, this tubulure finally being sealed off when the vacuum is completed.

35 Q. Why do you say that in this modified form of the King lamp, you would have used *platinum* for the 5020
lower wire *n*?

A. Because, as has been understood for the last fifty years, as set forth in my testimony above, platinum was the material specially adapted for effecting a permanently secure air-tight joint where the glass was fused directly to the wire. The fact is recognized in this very King patent in the passage where it refers to

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the upper conducting wire *d*, which is represented as "*sealed in*" to the glass and which is stated to be of platinum.

36 Q. What do you find to be the instruction of the King patent as to the size of the conductor used to give the light?

A. The patent describes two materials as adapted for the incandescent or light-giving portion of the lamp, one being platinum, the other carbon.
5022 In reference to the platinum, it says:

> "The platinum should be worked into those *exceedingly thin* sheets known as leaf platinum."

After describing a process for producing it, the patent continues:

> "In this way it may be obtained so thin
> "that on holding it before a printed page the
> "letters can be distinguished through it."

5023
In reference to carbon, it says:

> "That form of carbon found on the interior "of coal-gas retorts which have long been "used is well suited for this purpose and may "be worked into the form of *small pencils* "or *thin; plates*, by the aid of the saw and "file."

These directions indicate, as it seems to me, that the light-giving conductor, whether of platinum or
5024 carbon, should be made as thin as the known methods of manipulating those materials would admit, consistently, of course, with the burners having the requisite strength and exposing a sufficient surface to emit the required amount of light, and consistently also, with the conditions of the circuit in which the lamp is to be used.

37 Q. Would the reason for this instruction of the patent in regard to the smallness of the incandescent conducter have been apparent to the mind of a person conversant with the laws of electricity at the date of the King patent? 5025

A. It would have been. In the first place, such a person would have understood that it would be necessary to concentrate the electrical energy of the current upon a conductor of very small mass, in order to produce in it the extremely high temperature requisite for 5026
giving light. He would also have known that the incandescent conductor must be of very high resistance relatively to the other parts of the circuit, in order to confine the heating effects mainly to the incandescent conductor, where alone such effects would be useful; and this would necessarily imply not only a conductor of small mass, but one of very small cross-section. In addition to this he would have known that unless the carbon was very thin, it would have required too large a current of electricity to work it. The source of 5027
electricity referred to in this patent is a battery or a magneto-electric machine, and either of these sources of electricity at that date would have supplied only limited amounts of current; consequently, in order that the conductor should be raised to bright luminosity with such currents, it would be manifestly necessary that these conductors should be very thin.

38 Q. In your last answer but one you have indicated that the smallness of the King carbon burner would be limited by the several conditions of strength, 5028
light-giving surface required, and character of the circuit. Please explain a little more fully in regard to this matter.

A. As regards *strength*, it would, of course, be necessary that the conductor should be of sufficient size or volume to give it the mechanical strength required

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to allow it to be handled and placed in the lamp, and when there to sustain the action of the current without destruction.

As regards *radiating surface*, it is manifest that the size of the carbon must be so adjusted as to expose a radiating surface that will give the requisite quantity of light when the maximum intensity of heat has been reached.

As regards the character of *the circuit* in its effect
5030 upon the size of the burner, it is manifest that if a number of lamps are to be run in *series* it is not desirable that the resistance of the individual lamps, and consequently the length and thinness of their light-giving conductors, should be as great as when the same number of lamps are to be run in *multiple arc* or *parallel*. As I pointed out in my answer to question 7, describing the difference between series and multiple-arc, or parallel, connections or circuits, if we have a number of lamps con-
5031 nected in series their resistances are added to each other, and therefore, if the resistance of each lamp is high and a large number of lamps are to be used in the same circuit, the total resistance of the circuit will be such as would require the employment of a dangerous or inconvenient E.M.F. (electro-motive force or pressure) in order to maintain a current. On the other hand, if the lamps are arranged in parallel, then no increase in E. M. F. is required for a large number of lamps beyond that which would be needed for one
5032 and therefore each individual lamp may have a high resistance without involving any inconvenient or dangerous electro-motive force. Moreover, when the lamps are arranged in parallel, the *amount* of current, or current *strength*, required is proportional to the number of lamps used; and, in order that this may not be inconveniently large, so as to require main conductors of excessive size, the resistance of individual lamps ought

to be high, so as to diminish the amount of current required by each one. 5033

From the above it is manifest that an intelligent constructor, in making lamps under the King patent for use in parallel, would make the carbon conductors much thinner and longer than if the lamps were to be used in series; and yet, in both cases he would make the carbons as thin as the character of the circuit would justify, having, of course, due regard to strength and radiating surface.

39 Q. Suppose in the year 1878 you had been called 5034
upon to make incandescent carbon lamps under the King patent, for use in multiple arc; how would you have made them, first, as to to the area of the cross-section of the carbon, second, as to the degree of the vacuum and the method of securing it; and, third, as to the method of sealing the lamp?

A. I should have used a carbon conductor of the smallest cross-section I could secure, either by purchasing the same or by preparing one by any process 5035
known at the time, whether such process was known prior to the date of the King patent or had been invented between that time and the year 1878.

I should also have made the exhaustion as perfect as was possible by the use of any method for that purpose known up to the same date; and, if I desired to produce a portable lamp, I should undoubtedly have sealed the bulb by fusion at both ends, having both leading-in wires of platinum, and using a side tube by which to effect the exhaustion after the sealing in of 5036
the wires had been accomplished.

To have selected the best carbon for the purpose, or to have availed myself of any improved methods then known of preparing the carbon conductors, or of sealing in the leading-in wires, and of exhausting and sealing off the bulb, would have been simply the selection of materials and the application of methods well known

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in the art at the date in question as requisites to good workmanship. This, as I understand it, would have been merely the exercise of ordinary skill and would not have involved anything in the nature of invention,

40 Q. If in the same year, (1878) you had been called upon to make incandescent carbon lamps under the King patent, for use in series, how would you have made them as to the cross-section of the burner?

5038 A. I would have made the burner of larger cross-section than if the lamps were to be used in parallel and of shorter length, but in other respects should have made the lamps as if to be used in parallel. Although I should have made the carbons larger and shorter than those for lamps to be used in parallel. I should only have diminished the length and enlarged the size so far as would be necessary to avoid the necessity of employing an inconvenient or dangerous amount of E. M. F. in their operation. In other words I should
5039 h ve made the carbons as small as possible consistently with the conditions of the circuit on which they were to be used.

41 Q. Were the principles govering the relations of the resistance of the lamps to the character of the circuit employed, to which you have referred in your answer to Q. 38, known in 1878?

A. They had been perfectly well known for many years prior to that date, and had been applied very
5040 generally in various forms of electrical apparatus or instruments such as I have described in a previous answer as "translating devices."

42 Q. What is the present practice in regard to the construction of lamps to be used in series and in parallel; and what has been the practice in this regard since incandescent lamps came into use?

A. Those used in parallel are made of very high re-

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sistance, usually one hundred ohms or much higher when the lamps are connected directly with the dynamo; and when used in series the resistance is made quite low, from less than one ohm to six or eight ohms. The Bernstein series lamp, which is largely in commercial use, has a resistance of about one ohm; the Thomson-Houston and the Heisler series lamps, which are also largely in commercial use, have about the same resistance; the Edison "municipal" or series lamps have a somewhat higher resistance, but still very low 5042
as compared with those used in parallel. This same practice has always been carried out since incandescent lamps came into use.

43 Q. Have you one of the commercial "series" lamps, such as you have mentioned, and if so, will you please produce it?

A. I have a Bernstein series lamp which I now produce. I have measured the resistance of this lamp and find it to be $\frac{88}{100}$ ohms.

5043
The lamp produced is offered in evidence and marked "Defendant's Exhibit Bernstein Series Lamp."

44 Q. What difference, if any, is there in the construction of incandescent lamps used in series from that adopted for lamps used in parallel? I refer to the lamps in commercial use at the present time?

A No difference whatever, except in the thickness and length of the carbon conductors and the size of the 5044
leading-in wires. Of course the lamps using the thinner carbons can make use of smaller leading-in wires than those having thicker carbons. The construction of the globes, the sealing and exhaustion, and the processes used for making the carbons, as well as the method of attaching the carbon to the leading-in wires, are identical in the two forms of the lamp.

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45 Q. Do you know whether, prior to the year 1878 it was a common practice in sealing up glass vessels which were to be used for passing a current of electricity into a vacuum, to fuse the glass directly upon the leading-in wires before exhausting the vessel?

A This was universally practiced in the manufacture
of Geissler tubes; it was a practice which also was
adopted in the construction of Crookes radiometers,
in which a current of electricity was to be carried into
the exhausted glass bulbs. In all of these instruments
5046 the glass was first sealed by fusion directly upon the
leading-in wires, and then the bulb was exhausted
through a small tube connecting the bulb with the
pump; this exhaust tube was afterwards sealed off,
detaching the finished bulbs from the pump.

46 Q. Aside from the King British patent of 1845,
what statements do you find in regard to the size of the
burners or light-giving conductors of incandescent
5047 electric lamps in patents or publications prior to 1879,
and what do these show in regard to the state of
knowledge on this point prior to the time mentioned?

A. I find the matter of size referred to in various patents prior to the date named, and in a manner to convey substantially the same instruction as is contained in the King patent.

Thus, the British patent No. 14,198, granted to
Martyn J. Roberts in the year 1852, in describing the
Roberts lamp, speaks of the carbon conductor in one
place as a "*thin* piece of graphite, coke or charcoal, or
5048 other infusible body, being a conductor of electricity;"
and in another place, as "a piece of *very* thin graphite,
* * * * * As thin as conveniently can be made;"
and the corresponding claim is for "the production of
light by passing electricity through a *thin* infusible
body being a conductor of electricity."

A number of other patents and publications prior to the date mentioned refer to the use of "thin strips" and

"small pencils" and rods of carbon and other materi- 5049
als as the burners of incandescent lamps, and in the
British Patent of Lane-Fox, No. 3988, bearing date
October 9, 1878, the burner is stated to consist of "a
thin strip of wire or some suitable material, for which
purpose I prefer to use an alloy of platinum and iridium."
The patentee further says: "In order that the
electric force may be conveyed at a high tension, that
is, having high electromotive force, so that there may
not be very great loss from the resistance of the con- 5050
ducting mains of conductors, I make the lamps, when
I use an alloy of platinum and iridium, of lengths of
fine wires so that I may get high resistance without
having a large extent of luminous surface."

From these multiplied statements, contained in the
various patents referred to, I consider that it became
long ago, and prior to 1879, a well established and
generally understood principle for the construction of
incandescent lamps that the light-giving conductor
should be made as small in cross-section as possible— 5051
consistently, of course, as I have already explained,
with the strength of the material, the required radiating
surface and the character of the circuit.

47 Q. You have heretofore referred to the character of the vacuum that was called for by the terms of the King British patent of 1845; please state whether in other patents relating to incandescent lamps you find instructions of similar import?

A. I do; notably in British patent granted to Mar- 5052
tyn J. Roberts in the year 1852, No. 14,198. In one
place in this patent Roberts speaks of the conductor as
"enclosed in a vacuum or space not containing any
"oxygen or other matter which can cause the combus-
"tion or destruction of it when brought into an incan-
"descent state by the action of a current of electricity."

In another place he says:

5053 "The air is drawn out of G and as perfect a vacuum "as can conveniently be made obtained. When this "is done the stop-cock is shut and the apparatus is "then removed to its stand A."

And he also says that when the graphite is heated white-hot by the passage of the current "no combustion will ensue if the vacuum be perfect and no matter within the globe to cause combustion of the graphite." From this I should understand that as perfect a vacuum as was known to the art was to be used in preparing
5054 this lamp.

48 Q. If, at a date subsequent to the year 1852, say as late as 1878, you had been called upon to make incandescent lamps under the Roberts patent, how high a vacuum would you have made or attempted to make?

A. As high a vacuum as I could obtain with a Sprengel or Geissler pump, because the patentee is very emphatic in pointing out that as perfect a vacuum as possible is to be produced so that all matter capable of
5055 acting upon the carbon conductor should be exhausted from the globe.

49 Q. Would you in the year 1878 have anticipated difficulty in maintaining a high vacuum such as would be produced by the Sprengel pump, in a Roberts lamp closed in the manner described in the Roberts patent, that is, by screwing the globe down air-tight upon the stopper or support?

A. I should have anticipated considerable difficulty
5056 from my own experience as well as from that of others which experience had already led to the use of a fused glass joint as a means of closure if perfect security was desired. In fact, I think that with my knowledge of the subject at that time, I should not have considered it worth while to attempt to make the joint by means of the metal cap and stand, but should have adopted

the fused glass joint with which I was already familiar 5057
n connection with the Geissler tubes.

50 Q. What, if you know, was the specific resistance of the carbons used in arc lighting prior to the year 1879; and how does it compare with the specific resistance of the carbons of defendant's incandescent lamps in evidence in this suit?

A. In the first place, in regard to the specific resistance of the arc-light carbons, I have found a number 5058
of measurements made and published by high authorities, which show the following results. In order to make these easy of comparison, I have reduced them, when necesssry, to a form of expression in which the specific resistance of mercury is taken as unity—this being a common method of expressing specific resistances.

Thus, in the first place, I find a series of measurements by the distinguished physicist Matthiessen in Poggendoff's Annalen, Volume 103, page 428, published in 1858, as follows: 5059

Mercury,	1
Graphite,	23
Gas Carbon,	85
Bunsen Carbon,	41

These are the measurements given by Mathiessen of the materials named, and of these the "gas carbon" and the "Bunsen carbon" were used as the material of the rods or pencils for arc lighting.

The same author in the same work, Volume 103, page 428, in 1858, gives the resistance of carbon as 42 5060
(measured by the mercury unit).

Siemens, in Wiedeman's Annalen, Volume 10, page 560, published in 1880, gives thespecific resistance of carbon pencils made of gas-retort carbon as 43.

Again, Muraoka, Wiedemann's Annalen, Volume 13, page 307, published in 1881, gives the following:

5061

Faber lead-pencil (52 per cent. carbon) -	952.00
Gaudoin artificial carbons for electric light. -	55.15
Paris retort carbons, - - - - - -	52.23
Artificial carbon for electric light, - -	48.40
Artificial carbon for electric light, - -	41.17
Artificial carbon, Kaiser & Schmidt, - -	39.10
Artificial carbon, Heilmann & Co. - -	39.10
Siberian graphite; - - - - - - -	36.86
" " - - - - - - -	12.20

5062 Of these the second, third, fourth, fifth, sixth and seventh were those used for electric lighting.

I have also recently measured some carbons for arc lights, which have been in my possession for over twenty years, and find their resistance to be (again using mercury as the unit for comparison), as follows:

Sample (a) Square 0.192 by 0.203 inch, Resistance 40.20.

Sample (b) Square 0.209 by 0.219 inch, Resistance 66.15.

5063 I have also measured some other carbons for arc lights which came into my possession about twelve years ago, when arc lighting first began to attract great popular attention, and find the resistance of these (also referred to mercury as unity) to be as follows:

SAMPLES MADE BY BRUSH CO., CLEVELAND, O.

Sample (a)	Round 0.323 inch diam.		Resistance	39.54
" (b)	" 0.320 "	"	"	39.53

5064 SAMPLES MADE BY WALLACE AND WESTON.

Sample (a)	0.180 inch. - - -	37.82.
" (b)	0.238 " - - - -	69.67
" (c)	0.180 " - - - -	53.10
" (d)	0.241 " - - - -	64.24
" (e)	0.112 " - - - -	43.58
" (f)	0.388 " - - - -	82.20
" (g)	0.486 " - - - -	46.34
" (h)	0.486 " - - - -	45.84

Sample (f) was very rough, and its relatively high specific resistance was probably due to imperfections of manufacture. 5065

I have also measured a number of carbon rods for arc lights, or simular use which I purchased recently in the City of New York, and find their resistance to be (also referred to the same unit, mercury) as follows:

Carbon pencils recently bought in New York from Greely & Co., and Bunnell & Co.

MADE BY CARRÉ, PARIS. 5066

				Resistance.
Sample (a)	Round,	Diam.	0.278 inch.	41.29
" (b)	"	"	0.197 "	41.14
" (c)	"	"	0.194 "	41.81
" (d)	"	"	0.166 "	40.00
" (e)	"	"	0.164 "	38.32

MADE BY FARADAY CARBON COMPANY.

Sample (a)	Round,	Diam.	0.321 inch.	42.28	5067
" (b)	"	"	0.256 "	37.80	
" (c)	"	"	0.261 "	39.93	
" (d)	"	"	0.193 "	44.35	
" (e)	"	"	0.191 "	40.71	
" (f)	"	"	0.123 "	43.09	
" (g)	"	"	0.123 "	40.58	

MADE BY NATIONAL CARBON CO.

				Resistance.	
Sample (a)	Round,	Diam.	0.319 inch.	43.10	5068
" (b)	"	"	0.319 "	41.51	
" (c)	"	"	0.318 "	42.15	
" (d)	"	"	0.314 "	40.66	
" (e)	"	"	0.261 "	36.88	
" (f)	"	"	0.258 "	41.44	
" (g)	"	"	0.264 "	41.66	
" (h)	"	"	0.262 "	36.96	
" (i)	"	"	0.266 "	42.11	
" (k)	"	"	0.183 "	38.09	

5069

Sample	Round.	Diam.		inch.	Resistance.
" (l)	"	"	0.181	"	34.71
" (m)	"	"	0.183	"	38.48
" (n)	"	"	0.180	"	33.88
" (o)	"	"	0.183	"	36.22
" (p)	"	"	0.183	"	37.28
" (q)	"	"	0.128	"	58.26
" (r)	"	"	0.127	"	52.53
" (s)	"	"	0.128	"	49.13
" (t)	"	"	0.127	"	53.02

5070 I have calculated the specific resistance of the carbons in defendant's lamps in evidence from the figures stated in the stipulation relating thereto, and find it to be as follows (referring to the same unit, that is, the specific resistance of mercury):

Zig-zag lamp, specific resistance,	39.77
M lamp, " "	66.06
Tamadine lamp, " "	41.43

51 Q. What does the term "specific resistance" in
5071 this connection signify?

A. It means, in substance, the relative resistances of conductors of various materials of equal length and cross section, and is frequently expressed by saying that the conductor in question has so many units, or such a fraction of a unit, of resistance for a length of one inch and a cross-section of one inch or for a length of one millimetre and a cross-section of one millimetre; but it is also frequently expressed by taking some familiar or well known substance as unity and then ex-
5072 pressing the resistance of other bodies as related to this, the meaning being that for equal cross-section and length the resistance of the bodies named will be as many times that of the substance taken as unity as the figures given represent. In the tables or statements of resistances which I have myself used, I have taken mercury as the unity, as this was the most convenient way to reduce and compare various tables or statements of resistances found in different works.

5073

52 Q. To what do you attribute the relatively low specific resistance of the carbons in the defendant's lamps referred to above?

A. To the effect upon the structure of the carbon of the process of hydro-carbon treatment used in making them. By this process, which is described in the Sawyer and Man U. S. Patent No. 211,262, the pores originally existing in the carbons are filled up with solid carbon deposited from the gas in which they are heated, and this makes the carbons very dense and homogeneous in structure, and therefore better conduc- 5074
tors of electricity, or in other words conductors of lower specific resistance. With any given material, the specific resistance depends mainly upon the density of the material or the closeness of contact between the particles of which it is made up. The denser the structure, the lower the specific resistance will be.

53 Q. Does the resistance of carbon remain the same when the carbon is heated to incandescence as when it is cold? 5075

A. It does not. The resistance of carbon diminishes when its temperature is increased, and when it is heated to incandescence its resistence is only a little more than one-half that which it possesses when cold.

54 Q. Have you measured the resistance of the carbons of the two lamps in evidence, "Defendant's Zig-Zag Lamp" and "Defendant's M Lamp," when raised to their normal incandescence, and if so, please state what you find such resistance to be in each case? 5076

A. I have made the measurements referred to, and I find the resistance of the Zig-Zag lamp to be 75 ohms, and that of the M Lamp to be 41 ohms. The measurements were made while the lamps were subjected to the current intended for working them, as set forth in the stipulation referring to the lamps.

5077

55 Q. Which is the effective or actual resistance of the lamps when in use—the resistance measured when cold, as set forth in the stipulation you have referred to, or the resistance when measured hot, as set forth in your answer to the preceding question?

A. Manifestly the resistance when hot, as this is the resistance interposed by the lamp to the passage of the current and the only one, so far as the lamp is concerned, which has any effect upon the operation of the
5078 apparatus. It is more convenient to measure the resistance when the lamp is not in operation and the carbon is consequently cold, but the resistance when hot is always that which is taken into consideration in the construction of the apparatus, and this may readily be obtained by calculation from the cold resistance.

Cross-Examination of HENRY MORTON by MR. DYER.

Present counsel as before.

56 x-Q. Did you testify as expert for the complain-
5079 ant in the case of the Consolidated Electric Light Company against the McKeesport Light Company? If so, when was that testimony given?

A. I did testify in the case mentioned and my testimony was taken between April 10, 1889, and April 26, 1889.

57 x-Q. I read from your direct answer 20 in that case, on pages 1266 and 1267 in Volume II of Com-
5080 plainant's record, as follows:

"In the first place, Roberts's English patent No. "14,198 of 1852. On page 11 of this patent there "begins a description of an incandescent electric lamp "consisting of 'a thin piece of graphite, coke or char-"coal or other infusible body being a conductor of "electricity while it is inclosed in a vacuum or space "not containing any oxygen or other matter which "can cause the combustion or destruction of it when

5081

"brought into an incandescent state by the action of "the current of electricity.' There then follows a de-"scription of the lamp, having reference to a drawing. "In this description the incandescent conductor is re-"ferred to six times as 'graphite,' and never by any "other name. It is also shown in the drawing as a "straight rod held between two clamps. It would "therefore appear that in this patent there is no ref-"erence whatever to a conductor of an arched form,
"none whatever, nor the remotest suggestion as to 5082
"the employment of a fibrous or textile material which "might be shaped prior to carbonizing, and no refer-"ence, even the most remote, to anything having a "fibrous structure, except the one use of the word "charcoal, provided we understand that word in its "popular sense as meaning wood charcoal, and not in "its electrical sense as meaning such forms of carbon "as were generally employed in electric lamps. In my "opinion it is perfectly manifest that the word 'char-
"coal,' as used in this patent, is used in its technical 5083
"electric sense, and does not mean wood charcoal, but "does mean any of the various artificial carbon struc-"tures such as were used, and are used, in the produc-"tion of the ordinary electric light, viz., the arc light. "The repeated use of the name 'graphite,' and the "knowledge which existed at that date that graphite "possessed superior forms of resistance to any other "form of carbon except the diamond, would, I think, "of necessity result in the conclusion on the part of any
"one reading this patent that graphite or graphite- 5084
"like material, such as gas-coke or similar resisting "carbon, was the material to be used in carrying out "this invention, and that to use wood charcoal or any "like vegetable product would be to depart radically, "and probably with disastrous results, from the in-"structions here given.

"It is also to be noticed that in the description of "the Roberts Lamp, there is no instruction nor sug-

5085 "gestion as to the making the transparent lamp "chamber entirely of glass, but, on the contrary, the "structure is shown as a flask-shaped globe cemented "into a metallic cap through which the electric con- "ductors are passed, one of them, at least, being sur- "rounded by an insulating sleeve of ivory. From this, "I think it will be very manifest that not one of the "important and characteristic features, which I have "especially pointed out as distinguishing the invention "of the patent in suit, is found in this Roberts patent.
5086 "That is, it neither shows an arch-shaped incandes- "cent conductor, nor one made from vegetable fibrous "or textile material, nor an enclosing air-tight chamber "made wholly of glass, and, therefore, in no respects "at all, anticipates the invention of the patent in suit."

Did you give this testimony and do you still hold the opinion therein expressed?

A. I did so testify, and under the same conditions as are involved in the subject there under discussion I
5087 hold the same opinions still.

58 x-Q. I read from your deposition in that case, direct questions and answers 25 and 26, as follows:

"25 Q. In the light of our present knowledge, has "carbonized fibrous or textile material as distinguished "from other forms of carbon any peculiar fitness for "use as the conductor of an incandescent lamp, and "if so, in what does such peculiar fitness consist?

"A. In the light of our present knowledge we know
5088 "that to produce such an incandescent lamp as has "proved itself to be commercially successful, fibrous "vegetable material possesses special advantages, "which are, first, that it is readily formed or shaped "or may be obtained already formed or shaped prior "to carbonization, such forming or shaping including "the shaping into an arch form.

"In the second place, such material after carbonization lends itself readily to the treatment known as 5089 "'tempering' and 'treating,' whereby its mechanical "strength and uniformity of electric resistance can be "readily increased and controlled. Thirdly, such "material, after carbonization, is found to have a very "high specific electric resistance, which is of great im- "portance and value in the production of an incandes- "cent light although without importance and indeed, on "the contrary, an undesirable property in the electrodes "employed for an arc light. Fourthly, conductors of "this material have been found to possess remarkable 5090 "properties of mechanical strength enabling them to "resist shocks and strains to which they may be ex- "posed, such strength being combined with an elastic- "ity which is especially developed and utilized when "their shape is that of the arch or loop. Fifthly, by "the use of such fibrous vegetable structures it is com- "paratively easy to produce conductors which initially "are of substantially uniform resistance, such uniform- "ity being due both to equality of structure and of "cross-section throughout their length, and to the 5091 "purity of their material, namely, the absence of "mineral matter, which being as a rule of high resist- "ance in comparison with carbon, would introduce, if "present, great irregularity in this respect.

"26 Q. Has carbonized fibrous or textile material, as "distinguished from other carbon, any peculiar fitness "for use in arc lighting or in semi-incandescent lamps?

"A. Not taken as a whole. In other words some of "its distinguishing properties would peculiarly *unfit* "it for these uses and would more than neutralize any 5092 "beneficial effect from such properties as might be ad- "vantageous in arc lighting. For example, it is desir- "able that the specific resistance of the electrodes "should be as small as possible. If we could "make electrodes with no resistance at all they would "be perfect or ideal electrodes for this purpose. There-

5093 "fore a high specific resistance is in every way an un-
"desirable and injurious property. The capacity of "shaping prior to carbonization is of no practical "value in connection with arc-lights because the ma-"terials used for these lights are very readily gotten "into shape and usually are so shaped while in the "condition of powders already carbonized, or in other "words while in the condition of carbon powders.

"Their dimensions, also, are such that the question "of mechanical strength is entirely immaterial, since
5094 "their size gives them abundant resistance to any "shock to which they would ever be exposed. Uni-"formity of resistance, in the sense or to the degree in "which we consider it in the case of incandescent con-"ductors, is also entirely immaterial in the case of "the electrodes for arc lamps, in which such differences, "in this respect, as would be serious in the case of in-"candescent conductors, are quite immaterial. The "advantage coming from a purity in the material is "one that would have some effect in reference to the
5095 "electrodes for arc lights, but can be secured in the "manufacture of those articles far more readily than by "the use of fibrous vegetable material, since pure "carbon in the condition of lamp-black or other prepa-"rations, can be readily treated in the manufacture of "these electrodes, and will then produce a product "quite as pure as anything that can be obtained from "vegetable fibre. As these electrodes are never em-"ployed in an arch form, of course the capacity of as-"suming such form would have no value in connection
5096 "with them."

Did you give this testimony and do you still hold the opinions therein expressed?

Question objected to as not legitimate cross-examination.

A. I did so testify, and under the conditions involved

in the case there under consideration I hold the same opinion still. 5097

59 x-Q. I read from your deposition in that case direct questions and answers 44, 45 and 46 as follows:

"44 Q. Do you agree with Mr. Edison in the opin-"ion he expresses in his answers to questions 432 and "467 to 470 inclusive, that while the quality of high "specific resistance possessed by carbonized fibrous or "textile material is advantageous for lamps of high 5098
"resistance, it is not advantageous but rather the re-"verse for incandescent lamps of comparatively low "resistance?

"A. I do not at all agree with this statement, and "was very much astonished when I first read it in Mr. "Edison's deposition, and feel convinced that he could "not have given much thought to what he was saying "when he made this answer. In any system of electric "lighting by incandescence it is desirable that as much "of the resistance of the entire circuit as possible 5099
"should be concentrated in the incandescent conduct-"ors of the lamp. Where these lamps are to be em-"ployed in parallel arc, it is important that the total "resistance of each lamp should be very high, but when "the lamps are used in series, it is desirable that the "total resistance of each lamp should be relatively low; "but, since the production of light must in all cases be "proportional to the product, involving the resistance "as one factor and the current as another, it is mani-"fest that the specific resistance must in either case be 5100
"high in order that there should be enough of it in a "moderate length of the conductor to develop from the "current employed the light-energy which is desired. "If, as Mr. Edison states, a high specific resistance "was undesirable in an incandescent lamp when used "in successive series, then, of course, such lamps "might readily be made by the use of good conductors

5101 "such as the ordinary arc-light electrodes. The actual "fact is that a high specific resistance is desirable in "either forms of lamp, and all that can truly be said "in this regard as to difference, is that it is more im- "portant in order to meet certain mechanical condi- "tions in the case of the lamps run in parallel series, "than it is with the lamps run in successive series. "So far, there is a difference, but this is simply a "difference of degree, and does not authorize any such
5102 "broad statement as that which is contained in Mr. "Edison's answers referred to.

"45 Q. As a matter of fact, what sort of carbon is "used in series lamps of relatively low total resistance "which are in commercial use at present?

"A. Exactly the same kind of carbon as is used in "the lamps of high resistance, the difference being "that the conductors are made shorter and thicker in "the lamps of low resistance and longer and thinner "in the lamps of high resistance.

5103 "46 Q. Is it hard carbon or carbonized fibrous or "textile material?

"A. Carbonized fibrous or textile material."

Did you give this testimony, and are the facts and opinions therein stated and expressed still substantially true and in accordance with your views?

Same objection.

A. I gave the testimony referred to, and I consider the facts therein stated to be true to-day as they were then, and I hold the same opinions in reference to the
5104 same subjects.

60 x-Q. Do you recollect testifying as expert for the petitioners in November, 1888, in the case of the Royal Electric Company of Canada, petitioners and Edison Electric Light Company, respondents?

A. I have a general recollection of having testified in some such case at Ottawa in Canada.

5105

61 x-Q. What was the general nature of that proceeding?

It is stipulated that the proceeding referred to was upon a petition to annul a Canadian patent granted to Thomas A. Edison, November 17, 1879, number 10,654, which patent is referred to in the defendant's amended plea, second amended plea and answer, the grounds of said proceeding being set forth in
defendant's second amended plea. 5106

Answer waived.

62 x-Q. I read from a printed copy of the stenographer's notes of the testimony taken in that case, the following which purports to be a portion of your deposition:

"Q. Have you considered the patent which is in "question in this proceeding, number 10,654, granted "to Mr. Edison for improvement in electric lamps?

"A. I have. I have considered it carefully. 5107

"Q. You have a copy of it?

"A. Yes; I have a copy of it.

"Q. Now, the first claim reads as follows: 'I claim "as my invention, first, an electric lamp for giving "light by incandescence, consisting of a filament of "carbon of high resistance, made as described and se- "cured to metallic wires as set forth.' Will you say "what, in reference to the lamps I have been speak- "ing of, is covered by that first claim in this patent, 5108
"construing it, as we must do, by the specifications "which precede the claim?

"A. I think that claim clearly covers any form of "incandescent electric lamp, having in it a filament "made of carbon and having a high resistance. The "word filament implies that it is a fibre or thread. It "must be of carbon, of high resistance, and must be "connected by conducting wires. Those are the es- "sential features, and any lamp which included those

5109
"features manifestly comes under that claim. Of "course it involves with it some enclosure, since such "a filament could not be used in the open air. That "enclosure might be of the most varied character, so "far as this claim is concerned, and the conditions un-"der which they might be used. As long as these "things are present the invention would be repre-"sented.

"Q. Then the words 'electric lamp, consisting of so
5110 "and so,' are not confined to any special form of en-"closure?

"A. I think not, manifestly, provided it was of such material.

"Q. Will you describe the difference between high "resistance and low resistance as applied to carbon "filaments, and how the high and low resistance is "produced?

"A. Considering simply the question of high and low "resistance, high resistance means that which affords
5111 "a great resistance or opposition to the passage of the "electric current through it. Low resistance is the "opposite, something that allows the electric current "to flow through with little resistance. Now, the "amount of light developed in a conductor primarily "depends upon the amount of current and resistance. "If a great amount of current flows with little resist-"ance, little or no light would be effected, or if a small "amount of current flowed, there might be little light. "If, however, there is a great resistance and also ade-
5112 "quate current passing through against that resist-"ance, then notable light will be developed; so that "we must have a very large current if the resistance "is low, or very high resistance if the amount of cur-"rent be small.

"Q. Then it is the resistance to the current which "is afforded by the carbon that causes the carbon to "become incandescent?

"A. It is.

5113
"Q. If the carbon, then, were a good conductor, "the current would pass through it without becoming "heated and would show no light?

"A. Precisely, if it were so good a conductor as to "offer little resistance.

"Q. It is a conductor, but poor?

"A. It is in a certain sense a poor conductor. It is "a matter of comparison. There are a great many "poor conductors, but in its volume it is a poor con-"ductor.

"Q. What is it that makes the filament used in the 5114
"Edison lamp one of high resistance?

"A. The two facts of its being the substance carbon, "but more the other fact of its being very thin and a "very fine thread and filament. It is that which gives "it the high resistance.

"Q. I notice in the patent specifications that the in-"ventor states that the object is to produce electric "light by giving incandescence in lamps which have a "high resistance, and that the invention subsequently "described consists of 'a light-giving body of carbon 5115
"wire or sheets, coiled or arranged in such a manner as "to offer great resistance to the passage of the electric "current.' Then, later on, he refers to the history of "the art by commencing to show that hitherto such "and such things have been done. 'Heretofore light "by incandescence has been obtained from rods of "carbon of one to four ohms resistance.' I need not "read it. If you will look at that portion of the "patent in which he says he has reversed this process "you will see that he says, 'I have reversed this prac- 5116
"tice. I have discovered that even a common thread, "properly carbonized and placed in a sealed glass "bulb, exhausted to one-millionth of an atmosphere, "offers from one hundred to five hundred ohms resist-"ance.' He goes on describing the various parts of "the lamp; but which particular seems to be the main "feature of this invention and of this process?"

5117 "A. Manifestly, I think the carbon filament. Nearly "all the description is given to that, and it is also a "fact that, aside from the fact of the use of this car- "bon filament of high resistance, the other items were "old.

"Q. Known before?

"A. Yes.

"Q. And of course in his claim he does not claim "all of the matters to which he refers in his specifica-
5118 "tion?

"A. No.

"Q. Now just take up his lamp as we have it in "Exhibit 10—which is one of his lamps—and will you "just explain what portions of that combination are "old, taking them up and and as referring to this in- "vention?

"A. It was old to use glass globes, hermetically "sealed, having conducting wires passing through the "glass so as to conduct a current of electricity into
5119 "the apparatus and out of it again. It was likewise "old to have that same apparatus exhausted to a very "perfect vacuum. It was also old to have a filament "not of carbon, and of very high resistance, enclosed in "such a globe and to pass a current through it, so "heating it that it became luminous. All these things, "therefore, in the general sense, were old.

"Q. Then his invention, so far as that part of it was "concerned, is the production of the filament of car- "bon of high resistance contained, as you say, in a globe
5120 "or some enclosure, which will give light and capable "of being exhausted of air.

"A. Yes."

Did you give this testimony and do you still hold the opinion therein expressed?

Objected to as not legitimate cross-examination and as immaterial, and complainant's

counsel are notified that in pressing this or 5121
similar questions in relation to the Canadian Edison patent they are making the witness their own, and defendant's counsel will claim the right of cross-examining the witness upon all such matter.

A. I believe that this testimony is correctly reported as you have quoted it; but, though in a certain sense it might be correct for me to state that under the con- 5122
ditions involved in that case I would still hold the same opinion, such a statement would probably be misleading without such an explanation as I will now make. At the time of giving the testimony quoted, I understood from conversations with counsel in the case that my opinion as to the scope of the claims in this patent which was substantially a legal question, should be guided by certain judicial decisions which had been rendered in England in reference to an English patent 5123
covering the same ground; having this in mind I expressed an opinion as to the scope of certain claims in this Canadian patent, which is correctly reported in the quotation of your question. At that time, however, had I felt myself at liberty to interpret those claims without reference to any judicial decision and simply by the light of my own understanding of the language of the patent under consideration, I should have reached a very different conclusion, and such different conclusion is that which I now hold in regard to the same subject, looking upon it simply as a scien- 5124
tific expert and without reference to any judicial decisions or legal authorities.

63 x-Q. I call your attention to an article published in the American Gas Light Journal for 1879, and con-

5125 tinuing through the numbers of that Journal dated January 2, 1879, January 16, 1879, February 3, and February 17, 1879. The said article being entitled "Lecture upon the Electric Light by Professor Henry Morton, Ph. D. Are you the author of that article?

A. Yes, I am.

64 x-Q. Did you cause its publication in the numbers of the American Gas Light Journal referred to in my last question? Please explain the circumstances
5126 of its publication?

A. I furnished the material of that article to the Editor of that Journal at his request. Such material involving a great deal more in the way of detail and completeness than the article actually stated in the lecture referred to and delivered October 17, 1878. I draw attention to this in order that no misunderstandings should arise as to dates, since there may have been included in the article as published matter that was not known to me at the date of the delivery
5127 of the lecture.

65 x-Q. Do you recollect the fact of the publication of the article in the numbers of the journal referred to?

A. I do.

Counsel for complainant offers in evidence a copy of the article referred to in the last few
5128 questions and answers, and the same is marked "Complainant's Exhibit Dr. Morton's Gas Journal paper on the Electric Light."

It is stipulated that defendant's counsel may hereafter enter such objection to this exhibit as they may be advised.

It is stipulated that the copy of the article

offered in evidence, which is taken from Volume II of Defendant's Record in the case of Consolidated Electric Light Company against McKeesport Light Company, is a copy of the article as published, subject to the correction of errors in the copy by counsel for either party. 5129

66 x-Q. Do you recollect the fact that on or about December 22, 1879, you wrote a letter which was addressed to the editor of "The Sanitary Engineer," and 5130 which was published in that paper about that date, and is the copy of that letter as printed on pages 27 and 28 of Volume II of Defendant's Record in the McKeesport case, a correct copy?

A. I recollect writing that letter, and the copy referred to is a correct one.

Complainant's counsel offers in evidence a copy of the letter referred to by the witness taken from pages 27 and 28 of the record referred to and the same is marked "Complainant's Exhibit Dr. Morton's Sanitary Engineer letter." 5131

It is stipulated that the defendant's right of objection be and the same hereby is reserved.

67 x-Q. Do you recollect the publication of that letter as stated in my last question?

A. I do. 5132

68 x-Q. I call your attention to a copy of what purports to be an interview with you by a reporter of the *New York Times*, taken from that paper published on December 28, 1879, and entitled "A Scientific View of it." This copy appears on pages 29, 30 and 31 in Vol. II of Defendant's Record of the McKeesport case. Do you recollect the fact of this interview, of the publica-

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tion of this interview on December 28, 1879, and are you correctly reported in the interview as published?

A. I distinctly recollect the fact of the interview, but, of course, cannot say that I remember the date, but have no doubt whatever that the date as stated is correct, and feel satisfied that I was reported with entire substantial accuracy.

69 x-Q. Does the copy of the interview, as printed at the pages referred to in my last question, appear to
5134 you to be a substantially correct copy of the publication?

A. It does.

> Complainant's counsel offer in evidence the copy referred to and the same is marked "Dr. Morton's *Times* interview of December 28, 1879."

Defendant's right of objection reserved.

70 x-Q. Is the "Sanitary Engineer" communication
5135 referred to in the interview, the same as the complainant's exhibit Dr. Morton's Sanitary Engineer Letter?"

A. It is.

71 x-Q. Is the article referred to by you in the Sanitary Engineer Letter as having appeared in the *New York Herald* "of Sunday the 21st" the article entitled "Edison's Light" covering a full page of the *Herald* of that date which I now show you?

A. It is.

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> Complainant's counsel offer in evidence the *Herald* article of December 21, 1879, referred to in the last question and answer, and the same is marked "Complainant's Exhibit *Herald* Article on Edison's Light of December 21, 1879."

Defendant's right to object to this Exhibit reserved.

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72 x-Q. Do you recollect the publication in Scribner's Magazine for August, 1889, of an article entitled "Electricity in Lighting?"

A. I do.

73 x-Q. Did you write this article?

A. I did.

74 x-Q. I read from that article the following statement:

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"Admirable as is the system of electric-arc lighting, "for use in streets and open spaces and in workshops "or large halls, it is entirely unfit to take the place of "the numerous lights of moderate intensity, employed "for general domestic illumination.

"For this purpose it was at a very early period perceived that the incandescent or heating to luminosity "of a continuous conductor by an electric current was "the most promising method. It was also at a very 5139
"early period perceived that the conductor to be used "for this purpose must be one which would admit of "being raised to a very high temperature without being "melted or otherwise destroyed. The first material "which was thought of in this connection was platinum, "or one of its allied metals, such as iridium, which "have the highest melting-points among such bodies, "and are besides entirely unacted upon by the air at "all temperatures. In 1848 W. E. Staite took out a "patent for making electric lamps of iridium, or iri- 5140
"dium alloys, shaped into an arch or horseshoe form.

"One of the most serious difficulties, however, even "with these materials, was that, to secure from them "an efficient light, it was necessary to bring them so "near to their fusing-points that a very minute in- "crease in the current would carry the temperature "beyond this and destroy the lamp by fusing the con- "ductor. An escape from the difficulty was offered

5141 "by the use of hard carbon, such as that employed for "the electrodes of arc lamps, but here the compensating drawback was encountered, that this substance, "when highly heated, was attacked by the oxygen of "the air, or, in other words, burned. To meet this, "plans were devised for replacement of the consumed "carbon conductor and for its protection from the "air by enclosing it in a non-active gas or in a "vacuum.

5142 "Thus in 1845 a patent was taken out in England "by Augustus King acting as agent for an American "inventor named J. W. Starr, for an incandescent lamp "the important parts of which are represented in Fig. "14.

"Here a platinum wire is sealed through the top of "a small glass chamber constituting the upper end of "a barometer tube. This platinum wire carries at its "lower end a clamp, which grasps a thin plate or rod of "carbon, and also a non-conducting vertical rod or
5143 "support, which helps to sustain another clamp, which "grasps the lower end of the carbon strip and connects "it by a wire with the mercury in the barometer tube "below.

"By passing a current through the platinum wire, "and thence through the upper clamp, carbon strip, "lower clamp, wire, and mercury, the carbon strip "could be made incandescent, and was to a certain extent protected by the surrounding vacuum.

"Though this lamp produced a brilliant light it
5144 "proved in various respects unsatisfactory, and was "abandoned after numerous trials.

"Other inventors, as for example, Konn, of St. "Petersburg, continued to work with rods or pencils "of hard carbon and achieved a limited success, but "the irregularity and brittleness of the material seem "to have been an insuperable objection and drawback,

"and the problem of commercial electric lighting by "incandescent conductors yet remained without a "solution. 5145

"This was the state of affairs even up to the fall of "1878," * * *

Have I correctly quoted from the article in question, and do you still hold the opinion expressed by you in the matter quoted?

A. You have correctly quoted as far as you have gone, though your quotation stops at a comma, and I still hold the opinion expressed in this quotation taken 5146
in connection with its immediate context.

NEW YORK, March 8, 1890.

Met pursuant to adjournment at two P. M.

Present: Counsel as before, and the cross-examination of DR. MORTON was continued by MR. DYER as follows:

75 x-Q. I read from your deposition as it appears in the printed record of the McKeesport case as follows: 5147

"4 Q. Have you read complainant's patent "in suit—Letters Patent No. 317,676, granted May 12th, 1885, to the Electro-Dynamic "Light Co., of New York, as assignee of William Edward Sawyer and Albon Man, and "do you understand the same?

"A. I have carefully read this patent and "I believe that I understand it.

"5 Q. Have you read the depositions of "Prof. Cyrus F. Brackett, Prof. Geo. F. Bar- 5148
"ker, Prof. Wm. P. Wilson and Mr. Edison, "who have testified as experts in this case?

"A. I have.

"6 Q. Do you agree with the opinions expressed by defendant's experts, or some of "them, that there is not a sufficient description in the specification of the patent in "suit as to the character of the fibrous material to be used for the burner, its selection, its preparation for carbonization and "its carbonization to enable others generally

5149 "skilled in the art, as it existed prior to 1880,
"to produce a practically operative incandes-
"cent conductor without experiment? I call
"your attention particularly to Prof. Brack-
"ett's answers to questions 16 to 19 inclusive,
"cross-questions 55 to 57 inclusive, to Prof.
"Barker's answers to questions 22 to 27 in-
"clusive, Prof. Wilson's answers to questions
"5 to 29 inclusive, and Mr. Edison's an-
"swers to questions 412 to 435 inclusive, 439
5150 "to 441, 457 to 464½ inclusive. Please give
"your reasons for any opinion you may ex-
"press?

"A. I do not at all agree with the opinions
"expressed by the gentlemen named, and I
"think I can best make clear my reasons for
"coming to a different conclusion from theirs,
"by pointing out, in the first place, what I
"find in the patent referred to, as to the char-
5151 "acter of the fibrous material to be used for
"the burner, its selection, preparation and its
"carbonization.

"In the first place, at line 25th of the first
"page of the patent, I find these words:

"'An incandescent conductor of carbon,
"'made from a vegetable fibrous material.'

"At line 76 of the first page I find as fol-
"lows:

5152 "'In the practice of our invention we have
"'made use of carbonized paper, and also
"'wood carbon. We have also used such
"'conductors or burners of various shapes
"' * * * but we prefer the arch shape.'

"At line 87 of the first page I find as fol-
"lows:

"'No especial description of making the
"'illuminating carbon conductors, described

"'in this specification, and making the sub- 5153
"'ject matter of this improvement is thought
"'necessary.'

"At line 21, page 2d, I find as follows:

"'The advantages resulting from the man-
"'ufacture of the carbon from vegetable fib-
"'rous or textile material instead of min-
"'eral or gas carbon, are many.'

"Again, at line 45 of the second page, I 5154
"find the first claim expressed as follows:

"'An incandescing conductor for an elec-
"'tric lamp, of carbonized fibrous or textile
"'material, and of an arch or horse-shoe
"'shape, substantially as hereinbefore set
"'forth.'

"I also find in the second claim the ex- 5155
"pression 'carbonized fibrous material.' In
"the third claim, the expression 'carbon-
"ized paper,' and in the fourth claim, the
"expression 'consisting of carbon made from
"a fibrous or textile material having the form
"of an arch or loop.'

"With these quoted passages either taken
"by themselves or in connection with their
"context before him, it seems to me that one
"skilled in the art would have abundantly
"sufficient instruction as to the material to 5156
"be selected, its preparation and carboniza-
"tion. The prominent features pointed out
"by the quoted passages are, that the incan-
"descent conductor is to be made of a fibrous
"vegetable or textile material in the form of
"an arch or loop, and carbonized so as to be
"converted into such a conducting material
"as would be useful in an incandescent elec-
"tric lamp. The instruction that the mate-
"rial was to be at the outset of fibrous vege-

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"table or textile character, would at once
"instruct any one desiring to carry out the
"invention that he should employ preferably,
"or as the most natural thing, such textile
"material as exists in the form of cotton or
"linen thread, or vegetable fibre of any other
"sort which had been reduced to a textile
"shape, that is, brought into a condition fit-
"ting it for weaving or other method of pro-
5158 "ducing a textile fabric. The most natural
"thing or material for the workman to employ
"would thus be the ordinary cotton or linen
"thread of commerce of the better sort, that
"is, such as consisted of fine vegetable fibre
"and was of uniform cross-section. Any one
"having the most ordinary knowledge of the
"art would be, of course, aware that irregu-
"larities in the material or lack of uniformity
"in cross-section, would be highly injurious,
5159 "because they would lead to irregularities in
"the conducting power of the resulting car-
"bon conductor, which would be most injur-
"ious, if not fatal, to its utility. Next to
"cotton and linen thread, the workman de-
"siring to carry out the instructions of this
"patent, would, it seems to me, naturally
"consider such materials as are used in the
"weaving of baskets and other articles, and
"which consist of strips cut from various
5160 "forms of grass or reeds, and especially from
"bamboo, because these would be fibrous
"vegetable substances already reduced to
"the form of textile material, that is to a
"shape adapting them to the process of
"weaving in the manufacture of baskets or
"the like. If the workman were to go further
"than this, as he might do were it his object
"to produce incandescent conductors of a
"larger size, he might then seek among the va-
"rious woods those which most resembled in
"their structure the fibrous and textile mate-
"rials which had naturally presented them-

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"selves to him in the first instance. In the
"next place, having in the view the state-
"ment that the conductor was to be used in
"an arch form, he would, as a matter of
"course, give the material this arched form
"previous to carbonizing it, since he would
"certainly know that it would be much
"easier to bend or curve any of these mate-
"rials into the arched form while they were
"in their fibrous or textile condition than 5162
"after they had been carbonized. In the
"case of the textile materials this arch form
"would, of course, be given by simple
"bending, and even in the case of woods,
"having in view the direction that fibrous
"vegetable material was to be employed, the
"workman would realize that he ought to
"preserve and not destroy the fibrous char-
"acter of the material while reducing it to
"the arch form, and would, therefore, give it 5163
"this shape by bending, and certainly not by
"so cutting it as to run across the grain and
"thereby practically destroy or render useless
"the fibrous structure of the material em-
"ployed. In addition to these directions, the
"patent also tells the artisan that this arched
"conductor may be made of paper, and under
"this instruction it seems to me that if the
"said artisan were possessed of ordinary in-
"telligence he would, as a matter of course, 5164
"shape his paper material before carbonizing
"it, and would select a variety of paper con-
"sisting of pure vegetable fibre unadultera-
"ted with mineral matter. Many such varie-
"ties of paper were known in the arts and
"easily procured. It is hardly necessary to
"say that an intelligent artisan would also

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"select a paper of uniform thickness and fine
"structure and not a coarse and irregular
"specimen, which he would know must pro-
"duce an irregular and therefore inefficient
"conductor for an incandescent electric lamp.
"It would also be true that if the supposed
"artisan was familiar with the art of electric
"lighting, as it existed in 1880, he would know
"about the methods of tempering or treating
5166 "carbon conductors set forth in certain earlier
"patent of Sawyer and Man, and would there-
"fore be prepared to subject his carbon con-
"ductor to such treatment if he found it de-
"sirable or necessary.

"As to carbonization of the material after
"it had been selected and prepared by shaping
"it seems to me that no specific instruction
"would be needed, because anyone skilled in
5167 "the art would be quite familiar with such
"methods of carbonization as would be mani-
"festly efficient for the object in view. In
"other words, he would not need to be in-
"structed that to carbonize relatively small
"and delicate objects like these, they should
"be enclosed in air-tight crucibles, being
"either pressed between surfaces or imbedded
"in carbon powder or the like, in such a man-
"ner as to exclude air as far as possible.

5168 "Having thus stated what I myself find in
"this patent in the way of directions as to the
"selection of material, its preparation and
"carbonization, I will take up in order and
"consider the various statements made by De-
"fendant's experts as to this same subject.

"In considering the opinions expressed by
"defendant's experts, I should, in the first
"place, make the general remark that all

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"these gentlemen seem to have overlooked
"the true significance of the expression 'tex-
"tile material' and to have directed their at-
"tention almost exclusively to the term 'wood
"carbon.' They have also, as it seems to me,
"assumed that the artisan attempting to fol-
"low the directions of this patent would fail
"to consider at once *all* its instructions and
"suggestions and would refer to only one at
"a time and would then proceed to consider 5170
"that one with little or no reference to the
"state of the art and to the indications which
"the existing state of the art, would furnish
"him as guides in his selection of material and
"treatment thereof. They also seem to as-
"sume that in order to be practically useful,
"an incandescent lamp must be able to com-
"pete successfully in cost and convenience
"with illuminating gas and even to rival the
"improved incandescent electric lamps of the 5171
"present day, and they also, as I think, as-
"sume that to be practicable and useful, even
"in 1880, an electric lamp must have a car-
"bon conductor of higher resistance, and of
"more slender structure than many which are
"in successful commercial use, even at the
"present day. These partial, or piece-meal
"methods of considering the patent, and
"those various assumptions are, I think, quite
"unphilosophical and unwarranted, and when 5172
"they are corrected, all grounds for the opin-
"ions as to the insufficiency of the instruc-
"tions contained in this patent, disappear.

"Thus, for example, taking up first Dr.
"Barker's testimony as expressed in his an-
"swer to question 22, his first objection is
"that the expression 'a vegetable, fibrous
"material in contradistinction to a similar

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"conductor made from mineral or gas car-
"bon,' and the expression 'vegetable fibrous
"or textile material,' would cover thousands
"of distinct forms of vegetable materials,
"among which the artisan would be at a loss
"how to select, because unprovided with any
"criterion by which to discriminate. This,
"however, could only be so if the artisan in
"question failed to realize the force of the
5174 "suggestion contained in the term 'textile
"material,' and also failed to realize the force
"of the term 'fibrous,' as meaning distinctive-
"ly and characteristically fibrous, to a marked
"and practically effective degree, and finally
"also failed to realize that the state of the
"art instructed him that the carbon conduc-
"tor must be of uniform structure and conduc-
"ting power throughout its length. He must
5175 "also fail to realize that according to the di-
"rection of this patent the finished conduc-
"tor was to have an arched form.
"If, on the other hand, the intelligent arti-
"san realized all these things, then he would
"not see before him the thousands of vege-
"table structures among which Dr. Barker
"thinks he would be lost, but, as I have al-
"ready pointed out, would have clearly indi-
"cated to him, in the first instance, such tex-
5176 "tile materials as cotton and linen thread;
"in the next place, such less familiar textile
"materials as the split canes, bamboos and
"the like as were also used for textile pur-
"poses; and lastly and only as a more re-
"mote suggestion, the use of such woods as
"by their peculiar, regular and even, fibrous
"structure were allied to the textile materials
"which would naturally be his first choice.

"Dr. Barker next refers to the mention of 5177
"paper as a material for the production of
"the carbon conductors, and thinks that be-
"cause there are many varieties of paper,
"some of which, by reason of the mineral im-
"purities which they contain, or their coarse
"and irregular structure, would be unfit for the
"use indicated, the supposed artisan would
"be at a loss which to select, and could only
"determine this by repeated experiment. 5178
"This, however, I think, does great injustice
"to the intelligence and knowledge of the
"supposed artisan, who, I think, would un-
"doubtedly know that in order to produce an
"article from paper which was otherwise to
"be made from vegetable fibre, he must select
"a pure paper, not contaminated or loaded
"with mineral matter, and that to produce a
"carbon conductor of uniform resistance or
"conductivity, he must use a paper of fine 5179
"and uniform structure and thickness, such,
"for example, as the familiar Bristol board.
"If the artisan had selected such a paper he
"would undoubtedly have succeeded in pro-
"ducing a carbon conductor capable of oper-
"ating with entire success in an incandescent
"electric lamp, especially if he had also ap-
"plied his knowledge and judgment to the ex-
"tent of treating or tempering said conduc-
"tor in the well-known manner after it had 5180
"been carbonized. Among other reasons for
"this last conclusion I may state that during
"my experiments on incandescent lamps for
"the Lighthouse Board I operated many
"lamps whose carbon conductors were made
"from paper and that these lamps operated
"in a very satisfactory manner both as regards
"durability and efficiency.

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" Dr. Barker next takes up the expression
" ' wood carbon ' as though it stood alone and
" was to be considered without any limitation
" derived from other parts of the patent. The
" words as they stand in the patent are in this
" connection :

" ' In the practice of our invention we have
" ' made use of carbonized paper and also
5182 " ' wood carbon.'

" Now, as I have already pointed out, any
" artisan of the most moderate degree of in-
" telligence, if directed to make arch-shaped
" carbons from paper would unquestionably
" cut or bend the paper into the arch shape
" before carbonizing it, and if he found direc-
" tions or a suggestion as in the above quota-
" tion which coupled the making of carbons
5183 " from wood with the making of carbons from
" paper, there cannot be the least doubt that
" he would also proceed to shape the carbon
" arches from the wood before carbonizing it.
" Moreover, if he had studied the rest of the
" patent and had realized the force of what is
" there said about textile material, and veget-
" able fibre, and moreover knew something as
" to the necessity of uniform structure in the
" conductors of electric lamps, he would not
5184 " feel that the entire class of exogenous woods
" was presented to him for selection, but that
" his choice must be confined to those which by
" their uniform and fibrous structure adapted
" themselves for this use, and were, in fact,
" as closely as possible allied in these charac-
" teristics to the textile and fibrous vegetable
" structures which were manifestly the pre-
" ferred and specially indicated materials.

" Had he used such knowledge and judgment 5185
" as I have above indicated, and had he also,
" for further security, applied the process of
" tempering or treatment, I have no doubt
" that he would have produced directly and
" without experiment an incandescent con-
" ductor for an electric lamp which, at the
" date of the patent, would have been entirely
" operative and indeed commercially valuable
" in certain locations, although it probably 5186
" would not have competed in economy with
" illuminating gas or with the improved incan-
" descent lamps of the present day.

" Near the conclusion of this answer 22,
" Dr. Barker uses these words:

" ' The bare statement of the patent in suit,
" ' therefore, that the material to be used for
" ' the production of the carbon conductor
" ' (which is the essential feature of an incan- 5187
" ' descent lamp), is vegetable fibrous material,
" ' seems to me to be utterly vague, indefinite
" ' and unsatisfactory, and does not seem to
" ' me to be such a full and complete descrip-
" ' tion as would enable a person skilled in
" ' the art as it existed at the time the said
" ' patent was applied for, to produce a prac-
" ' tically operative incandescent conductor
" ' without experiment.'

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" Now, if the assumption here made by Dr.
" Barker was correct ; if the patent only con-
" tained the bare statement which he makes,
" then his conclusion might be warranted ;
" but in order to secure this premise, Dr.
" Barker is obliged to ignore all that the
" patent says about textile material and the
" arch-shape of the conductor, and all that is

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"implied in these and other parts of the
"document. When these matters are taken
"into consideration, then the statement of
"the patent is no longer in the crude and
"bare condition to which Dr. Barker would
"reduce it, but is fully clad with abundant in-
"struction such as would enable one skilled in
"the art, without experiment, to produce not
"only one, but several varieties of operative
5190 "incandescent conductors for electric lamps.
"In Dr. Barker's answer to question 23, he
"points out very correctly that there are
"many kinds of paper, and also of wood,
"which would not answer for the construc-
"tion of an incandescent electric lamp, and
"to his remarks on this subject I will only
"add that this would be equally manifest to
"an intelligent artisan who might be called
"upon to put in practice the invention of
5191 "the patent in suit, and that such artisan
"would discard such varieties of wood and
"paper, just as Dr. Barker has done, without
"experiment.
"In his answer to question 24 Dr. Barker
"says in substance that he considers ex-
"plicit directions would be necessary as to
"the shaping and carbonizing of the conduc-
"tors, and that said directions are confes-
"sedly not given in the patent, but are
5192 "there stated to be unnecessary. I think
"that Dr. Barker's error in this, as in other
"cases, arises from his having overlooked or
"failed to appreciate what the patent says
"about textile materials. Had he taken this
"into consideration, he must, I think, have
"seen that the shaping of the material, or
"the selection of the same ready prepared

"in the desired shape, was a matter not only 5193
"suggested, but made, in many cases abso-
"lutely unavoidable, and that this having
"been done, it was manifestly unneces-
"sary to instruct any one familiar with
"the art as to methods of carbonizing,
"since these were thoroughly well known
"and clearly defined as to such mater-
"ials as are involved in this case. It would,
"indeed seem almost an absurdity to tell a 5194
"workman who had been instructed to make
"a carbon in an arched form out of a thread
"of some sort that he was to bend the
"thread into an arched form, and then clamp
"it between smooth surfaces of resisting ma-
"terial or surround it with carbon powder
"enclosed in an air-tight crucible, and heat
"it in a furnace, because it would require
"more ingenuity than most people possess
"to devise any other possible way of doing 5195
"the thing directed in the first case.
"In his answer to question 25, Dr. Barker
"says in substance that it would make all the
"difference in the world as to the efficiency
"of the conductor made from wood, whether
"it was cut with the grain or across the grain,
"and that the patent contains no specific in-
"structions in this regard and is therefore de-
"fective. I agree with Dr. Barker entirely
"as regards his facts, but not as to his con- 5196
"clusion. Any artisan acquainted with this
"art would know precisely what Dr. Barker
"does on this subject, and therefore would
"need no directions. In fact, to tell him not
"to cut his conductor across the grain would
"be as much of a reflection upon his intelli-
"gence as to tell him not to make notches in
"it or to make it of unequal section in differ-
"ent parts.

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" Dr. Barker's answer to the 26th question
" is substantially an amplification of what he
" says in the previous answer, and only ex-
" presses what any intelligent workman would
" know as to the proper or improper means
" of shaping a piece of wood which was in-
" tended, after carbonization, to be used as
" the incandescent conductor of an electric
" lamp.

5198 " In his answer to the 27th question, Dr.
" Barker states that an arched carbon made
" out of wood cut across the grain would not
" be useful as a conductor for an incandescent
" lamp, and in this I agree with him, as I
" think would any intelligent artisan familiar
" with the art of electric lighting as it existed
" in 1880.

" Turning next to the testimony of Prof.
" Brackett, in his answer to question 16 he
5199 " says, in the first place, that the instructions
" of the patent are insufficient as regards the
" selection of material. This opinion he ap-
" parently forms on the statement in the pat-
" ent that the patentees have used carbonized
" paper, and also wood carbon, taking this
" statement alone, and making no use of any-
" thing else in the patent to qualify or explain
" it. Like Dr. Barker, he assumes that the
" artisan who is attempting to follow the direc-
5200 " tions of this patent would take this sen-
" tence by itself, and would be ignorant as to
" the rest of the patent and the state of the
" art; that he would consequently select in-
" differently any kind of paper, no matter how
" impure and loaded with mineral matter, and
" no matter how rough and irregular in struc-
" ture it might be; that similarly he would,
" as it were, go into the forest or to the wood

" pile and take the first stick he picked up 5201
" and proceed to use it. After what I have
" said as to the actual instructions contained
" in the patent, and as to this method of
" piece-meal discussion, it is not necessary
" that I should here say more than that such
" an artisan as Prof. Brackett's remarks here
" imply, is not the artisan of ordinary intelli-
" gence, skilled in the state of the art, to
" whom the patent is addressed, but must be 5202
" one either lacking intelligence and knowl-
" edge, or not making use of the same in his
" attempt to put in operation the invention of
" the patent.

" In his answer to question 17, Prof. Brack-
" ett goes over the same ground as Dr. Barker
" in reference to the necessity of cutting the
" carbon from wood with the grain and not
" across it, and I would only remark that I
" quite agree with him, but feel confident that 5203
" any intelligent artisan would see this thing
" just as Prof. Brackett and I do, without any
" experiment being necessary to satisfy either
" him or us as to the result.

" In his answer to question 18, Prof. Brackett
" points out, in substance, that only a small
" fraction of the entire number of vegetable
" growths would be adapted to the manufac-
" ture of efficient carbon conductors for in-
" candescent lamps. In this statement, I 5204
" have no doubt that he is substantially cor-
" rect, but I do not understand that he has
" arrived at this conclusion only at the end
" of an immense series of experiments in
" which all these materials have been
" tested, but that he reaches this conclusion
" as a matter of deduction from his general
" knowledge concerning the conspicuous

5205 —
"characteristics of the vegetable world and
"the requirements of a carbon conductor for
"an electric lamp. This, I think any in-
"telligent artisan, with the full text of this
"patent before him, would do equally well,
"and would be saved from any unnecessary
"and unsuccessful experiments by those con-
"siderations fully stated in the early part of
5206 "my present answer, which would lead him
"to select only those few vegetable fibres
"which would produce efficient conductors,
"and not any of the numerous class which
"would be manifestly unfit.

"In his answer to question 19, Prof.
"Brackett states in substance that he does
"not think there existed in the state of the
"art in January, 1880, anything which would
"supply the deficiencies he finds in the pat-
5207 "ent. With this I so far agree that if these
"deficiencies existed, or in other words, if we
"took a single phrase in the patent and con-
"sidered it alone, we could not supply the
"imperfect instructions secured in this way
"by going to the state of the art, since it was
"precisely the invention set forth by this
"patent as a whole which added to the exist-
"ing state of the art the instructions which
"Prof. Brackett finds lacking in his selected
5208 "fragments.

"In answers 55 and 56 Prof. Brackett
"says in effect that the terms "fibrous" and
"'textile' cover in his opinion a great
"variety of substances and therefore are in-
"definite. This would be true if these words
"stood alone, but standing as they do in this
"patent in connection with the production of
"arch-shaped conductors for incandescent
"lamps they are, as I think I have already

"sufficiently shown, exceedingly clear and 5209
"precise, and would lead anyone who really
"desired to carry the invention into practice,
"directly to those materials which experience
"has shown are of all others best fitted for
"the construction of incandescent lamps.

"In his answer to question 57 Prof. Brack-
"ett thinks that the carbonizing process
"ought to have been explicitly described;
"that is to say, as to whether, in the case of 5210
"wood, the conductor was to be bent into an
"arched form before carbonizing or cut into
"such a form, the cutting involving, in the
"end, a carbon in which the grain would be in
"part cross-wise. As I have already pointed
"out, it seems to me that directions on this
"subject would be entirely superfluous and
"that any intelligent artisan would adopt the
"expedient of bending the wooden blank be-
"fore carbonizing, as a matter of course.' 5211

"In reference to the testimony of Mr.
"Edison and Prof. Wilson, I think I can
"avoid unnecessary repetition by saying that
"I find in them nothing substantially differ-
"ent from what I have commented upon in
"the testimony of Dr. Barker and Prof.
"Brackett, except that they seem to make
"more emphatically the assumption that for
"a practical incandescent lamp an extremely 5212
"fine or thin fibre is absolutely essential,
"and that the patent in suit requires that
"such fibre should be made out of wood. As
"regards this I should say that modern
"practice in electric lighting completely dem-
"onstrates that a very fine fibre is by no means
"universally necessary or desirable. In fact
"the Edison Company, in what they call

5113
"their Municipal system, use lamps with "carbons very many times as thick as those "to which Mr. Edison specially refers "in his testimony, and which are the "kind commonly employed by his com-"pany in household illumination. I "might also refer to complainant's "exhibit Thomson-Houston lamp, and "complainant's exhibit Bernstein lamp.
5114 "as showing incandescent electric lamps "which are used commercially to a consider-"able extent, and which have carbon con-"ductors even thicker than those of the "Edison municipal lamp. Still further, the "lamps used in the Heissler system have car-"bon conductors still thicker than any of "these. In all these cases the lamps are "used in successive series; that is, are so "connected that the current passes from one
5115 "lamp to the other in succession. It is "manifest, therefore, that a very fine fibre is "no essential condition for an operative or "even a commercial incandescent lamp. It "is also manifest that the patent in suit is "very far from suggesting that the only or "usual material for the production of the car-"bon conductors is to be wood. On the con-"trary, as I have already pointed out, the
5216 "first or most natural selection of an artisan "under the instructions of the patent, would "be a thread or string, and if this was em-"ployed it is manifest that Mr. Edison cer-"tainly could not raise any question as to its "operativeness, and Prof. Wilson has not "raised any which would have any force, if "we assume the carbonization to have been "effected in accordance with the well known

"state of the art and the exercise of reason- 5217
"able intelligence.

"In such cases as make it desirable to use "thick carbons, wood, under the conditions "which I have previously pointed out, could "undoubtedly be employed with success, and "the difficulties of selection would be un-"doubtedly less than in cases where a fine or "delicate carbon was required, just as in
"every department it is easier to make a 5218
"large or coarse thing than a delicate or fine "one, but in each case fairness requires that "similar and not dissimilar things should be "compared and that we should not bring into "comparison the material of the most deli-"cate modern lamps with the roughest and "coarsest of those suggested in the patent.

"In view of this I think it will be very evi-"dent that the insufficiency pointed out by
"Mr. Edison and Prof. Wilson as well as de- 5219
"fendant's other experts, does not exist in "the patent in suit, but only in the minds of "those gentlemen, and result from their erro-"neous assumptions in various directions "which I have pointed out and from their "partial or piece-meal discussion of the pat-"ent, whereby they have failed to appreciate "the true meaning of its various statements, "which can only be properly understood, as
"is the case with almost every document, 5220
"by being considered in their mutual relations "and as explanatory one of the other.

* * * * *

"12 Q. If carbons very much thicker than "the filaments to which Prof. Wilson refers "were to be made, would the defects to which "he refers be fatal or very serious ones, so "far as most of the woods are concerned?

5221 "A. Not necessarily, and especially not if "the process of tempering and treating set "forth in the earlier patent of Sawyer and "Man was availed of.

"13 Q. To what process do you refer, and "how would this serve to remedy the defects "mentioned by Prof. Wilson and defendant's "other experts?

5222 "A. The process to which I allude is that "which is set forth in two modifications in "the patents to Sawyer and Man, one of "which is No. 210, 809, Dec. 10, 1878, and "the other No. 211, 262, Jan. 7, 1879. In "the first of these, the process is described in "the following words, having reference to the "gases that may be occluded by the materials "enclosed within the lamp:

"'To drive these out, we pass an electric
5223 "'current through the conductors *x*, *x*. The "'carbon pencil N. is intensely heated, and "'considerable heat having extended through-"'out all the enclosed material, thus driving "'out occluded gases, the operation of ex-"'haustion and refilling with nitrogen is con-"'tinued until finally all the elements of dan-"'ger are eliminated from the lamp.'

5224 "The other process, or modification of the "process is referred to, in substance, in the "following words of the last named patent:

"'We have found that a pencil of carbon "'immersed in a hydro-carbon liquid and "'heated to an extremely high temperature "'by the voltaic current is not itself attacked, "'but decomposes the surrounding matter, "'the carbon of which enters and fills up its "'pores to an extent impossible, except with

"'matter in a very attenuated state, and de- 5225
"'posits a perfectly homogeneous layer, gen-"'erally of a light gray color upon the ex-"'terior surface.' * * * *

"'In this process it would seem that the "'carbon is never in contact with the liquid "'in which it is immersed, but surrounded "'by a carbonic gas of a very high tempera-"'ture.'

"The reason for this treatment is given at 5226
"the end of the paragraph immediately pre-"ceding the above quotation, in these words:

"'Carbons of the ordinary sort, when heated "'by the electric current, exhibit points and "'lines of unequal brilliancy. Carbons pre-"'pared by our process, when so heated, "'glow with a uniform brilliancy through-"'out.'

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"The tempering process described in the "first of these patents seems to be a sort of "fritting or agglomeration accomplished by "the combined influence of a very high tem-"perature, which softens without fusing or "vaporizing the particles of carbon, and the "exhaustion by which their occluded gases are "extracted and their molecules thus allowed "to come into closer contact. Its effect is to "contract and solidify the carbon conductor 5228
"and thus to render it more uniform in char-"acter and more capable of resisting destruc-"tive influences. The treatment described in "the second patent, as the words I have "quoted clearly show, consists in a local de-"composition of the hydro-carbon vapor, by "which the conductor is surrounded during

5229 "this treatment, with the consequent deposit
"of carbon upon the parts of the conductor
"adjacent to where the decomposition takes
"place.
"Now if, as originally made, this carbon
"conductor had a point of partial fracture or
"imperfect conductivity as compared with the
"rest, such point would be more highly
"heated by the current passing through, than
5230 "the remainder of the conductor, and, there-
"fore, a greater decomposition and deposit of
"carbon would occur at this point, thereby
"filling up the gap or curing the defect in an
"efficient manner. An extended experience
"has shown that a conductor, having consid-
"erable irregularities when first prepared,
"may be brought to state of great unifor-
"mity and to an excellent condition for use
"by this treatment.
5231 "14 Q. How largely have these two pro-
"cesses of expelling occluded gases and
"hydro-carbon treatment been used in the
"commercial manufacture of incandescent
"lamps since 1880, and what is their impor-
"tance or practical value in such manufac-
"ture?
"A. The process of extracting occluded
"gases has been, I believe, employed univer-
"sally in the manufacture of all electric lamps,
5232 "and the hydro-carbon treatment has been
"applied in the majority of lamps, although
"I believe it is not universally used. One or
"both of these treatments I believe to be es-
"sential for the success of an incandescent
"lamp factory at the present time. In other
"words, I do not think that a manufacturer
"who discarded both these treatments, could
"at all compete with those who used them

"and he could only be successful, if he omit- 5233
"ted the hydro-carbon treatment, so long as
"he confined his selection of material to a
"very narrow range, and at the the same time
"manufactured his lamps on a very large
"scale.

* * * * * *

"19 Q. Have you read the testimony of
"Profs. Brackett and Barker herein, and ex-
"amined all the patents and publications put
"in evidence by the defendants relating to the 5234
"prior state of the art?
"A. I have.
"20 Q. Defendant's experts have expressed
"the opinion that in view of the prior state
"of the art as shown in said patents and pub-
"lications, there was "no novelty in the use
"of vegetable fibrous carbon as the incandes-
"cent conductor of the lamp of the patent in
"suit." Please state if you concur in this
"opinion, and give your reasons for any opin- 5235
"ion you may express. I call your attention
"particularly to Prof. Brackett's answers to
"direct question 5, and cross-questions 41, 42
"and 43, and Prof. Barker's answers to direct
"questions 9 and 47 and cross-questions 56
"to 65 inclusive.
"A. In his answer to question 5, Prof.
"Brackett enumerates and describes a long list
"of patents and publications which he there
"seems to think in some way or other antici- 5236
"pates the invention set forth in the patent
"in suit, but in his answers to questions 41,
"42 and 43, he narrows down this broad field,
"by admitting that the best references as re-
"gards the use of a fibrous carbon, or carbon
"made from a fibrous substance, are to be

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"found in a paper by Violette, the description
"of Sidot's process, and the Binks' English
"patent; and as anticipating the combination
"of the second claim of the patent in suit,
"that is, the combination of an incandescent
"conductor of carbonized fibrous materials
"with a transparent, hermetically sealed
"chamber, he finds the best anticipations in
5238 "the English patent to DeMoleyns, that to
"Greener and Staite, that to Shepard, that
"to Roberts, and the Lodyguine publication.

"Dr. Barker, in his answers 9 and 47, in effect
"agrees with Prof. Brackett as to his large
"number of anticipations, but in his answers
"51 to 65 inclusive, he also limits this broad
"field to the following publications, viz., Eng-
"lish patents to Roberts, Shepard, Greener
"and Staite, and Konn, and the Lodyguine
5239 "publication. Combining these together, we
"have the English patents to Roberts, Shep-
"ard, Greener and Staite, and the Lodyguine
"publication, agreed to by Prof. Barker and
"Brackett as the best anticipations, and the
"patents of Binks, Konn and De Moleyns,
"and the papers of Violette and Sidot re-
"ferred to by one or the other of these gen-
"tlemen.

"These I will consider in the order in which
5240 "I have just named them.

"In the first place, Roberts' English patent
"No. 14,198, of 1852. On page 11 of this
"patent there begins a description of an in-
"candescent electric lamp consisting of 'a thin
"'piece of graphite, coke or charcoal, or other
"'infusible body being a conductor of elec-
"'tricity while it is enclosed in a vacuum or
"'space not containing any oxygen or other

"'matter which can cause the combustion or 5241
"'destruction of it when brought into an in-
"'candescent state by the action of the cur-
"'rent of electricity.' There then follows a
"description of the lamp, having reference to
"a drawing. In this description the incan-
"descent conductor is referred to six times as
"'graphite,' and never by any other name.
"It is also shown in the drawing as a straight
"rod held between two clamps. It would
"therefore appear that in this patent there is 5242
"no reference whatever to a conductor of an
"arched form, none whatever, nor the re-
"motest suggestion, as to the employment of
"a fibrous or textile material which might be
"shaped prior to carbonizing, and no refer-
"ence, even the most remote, to anything
"having a fibrous structure, except the one
"use of the word charcoal, provided we un-
"derstand that word in its popular sense as
"meaning wood charcoal and not in its elec- 5243
"trical sense as meaning such forms of carbon
"as were generally employed in electric lamps.
"In my opinion, it is perfectly manifest that
"the word 'charcoal' as used in this patent,
"is used in its technical electric sense, and
"does not mean wood charcoal, but does mean
"any of the various artificial carbon struc-
"tures such as were used, and are used, in
"the production of the ordinary electric light
"viz., the arc light. The repeated use of the 5244
"name 'graphite,' and the knowledge which
"existed at that date that graphite possessed
"superior forms of resistance to any other
"form of carbon except the diamond, would
"I think, of necessity result in the conclusion,
"on the part of anyone reading this patent
"that graphite or graphite-like material, such

5245 "as gas-coke, or similar resisting carbon, was "the material to be used in carrying out "this invention, and that to use wood char- "coal, or any like vegetable product, would be "to depart radically, and probably with dis- "astrous results, from the instructions here "given.

"It is also to be noticed that in the de- "scription of the Roberts lamp, there is no "instruction nor suggestion as to the making
5246 "the transparent lamp chamber entirely of "glass, but, on the contrary, the structure is "shown as a flask-shaped globe cemented "into a metallic cap, through which the elec- "tric conductors are passed, one of them, at "least, being surrounded by an insulating "sleeve of ivory. From this I think it will "be very manifest that not one of the im- "portant and characteristic features, which I
5247 "especially pointed out as distinguishing the "invention of the patent in suit, is found in "this Roberts patent. That is, it neither "shows an arch-shaped incandescent conduc- "ductor, nor one made from vegetable "fibrous or textile material, nor an enclosing "air-tight chamber made wholly of glass, "and, therefore, in no respects at all, antici- "pates the invention of the patent in suit.

"Considering next the Shepard Patent No.
5248 "13,302 of 1850, I find this to describe, at "page 9, an apparatus which may be cor- "rectly described as one for producing light "by what is known as the arc-incandescent "system, that is, a system in which light is "produced by the passage of an electric "current through the high resistance pro- "duced by the imperfect contact between "two pieces of carbon, one of which is con-

"tinually fed forward as it is consumed at the 5249
"end where the imperfect contact exists. In "the apparatus described in this patent, "there is a small cylinder of charcoal sup- "ported and guided by a vertical metal tube, "within which it slides. The lower end of "this rod of charcoal rests on the upper end "or apex of a cone of 'prepared char- "'coal or coke.' Both of these are sup- "ported within a glass globe having a care- 5250
"fully luted stopper, and proper electrical "connections. The only available light "produced in t is apparatus would be that "developed at, and close to, the point of "contact between the conical point of pre- "pared charcoal or coke, and the end of the "cylindrical rod of charcoal, because the "rest of the charcoal would be enclosed "within the copper tube. Even then, if we "assumed that in this case this thin rod of 5251
"charcoal was made of wood charcoal, which "perhaps it may be in view of the distinction "that the little cone D is of 'prepared charcoal "or coke,' the thin rod of charcoal would not "act as the incandescent conductor of an elec- "tric lamp, because, in the first place, even if "it acted by incandescence, the light so pro- "duced would not be availed of in the lamp, "and, secondly, because it would not act prop- "erly by incandescence, but could only operate 5252
"by the arc-incandescent action which I have "before stated. In addition to this, it is mani- "fest that there is no suggestion of an arched "form, nor of the use of vegetable fibrous or "textile material in any way in which the pe- "culiar properties of such substances would "come into play. I should therefore say

5253 "that, in the first place this was not an in-
"candescent lamp in the proper sense of that
"word at all; that it had no incandescent
"conductor in the proper sense of that ex-
"pression as constituting part of an electric
"lamp, and nothing which would either sug-
"gest or admit of making such a conductor in
"an arched form, and likewise no suggestion
"of the use of fibrous or textile material in
5254 "the production of any part of the lamp. It
"is therefore, plainly no anticipation of the
"patent in suit.

"Considering next the patent of Greener
"and Staite, No. 11,076, of 1846, I do not
"find that this describes any form of appara-
"tus, but in the first place, simply states in
"general terms that the inventors propose to
"illuminate various places by means of solid
"prisms or cylinders of carbon enclosed in
5255 "air-tight vessels of glass or some other trans-
"parent substance, and ignited, or rendered
"luminous, by currents of voltaic or magnetic
"electricity, such carbon being previously
"freed from the impurities with which it is
"ordinarily combined, etc. The patentees
"then proceed to describe at length their
"method of producing the carbon material, in
"which they start with lamp-black or charcoal
"or coke all reduced to powder. These pow-
5256 "ders they then treat with acids, alkalies and
"water, and, having dried them, form from
"them solid prisms or cylinders by means of
"hydraulic or other presses. They then pro-
"ceed to describe the uses of these prisms or
"cylinders in a manner which is only consis-
"tent with the supposition that they are em-
"ployed for arc lights, and then describe a
"further use which is only reconcilable with

"the idea that they intended to employ their 5257
"artificial carbon cylinders in the manner
"of the arc-incandescent lights. Taking it
"altogether, this patent clearly describes no
"structure whatever which can be regarded
"as constituting an electric lamp, but it does
"describe the manufacture of prisms or cylin-
"ders out of various forms of carbon reduced
"to powder. It says absolutely nothing
"about forming conductors in an arch shape, 5258
"and is equally silent as to the use of any
"fibrous or textile material in the production
"of carbon conductors, because I do not re-
"gard the reference to powdered charcoal as
"containing the faintest suggestion concern-
"ing the utility of a fibrous or textile mate-
"rial in the production of an arch-shaped
"conductor for an electric lamp. As this
"patent, then, contains not one of the ele-
"ments constituting the invention of com- 5259
"plainant's patent, I cannot see the slightest
"ground for referring to it as an anticipation
"of that patent.

"Turning next to the Lodyguine publica-
"tion in the 'London Journal of the Society
"of Arts,' August 27, 1873: This, as I under-
"stand it, is an abstract or translation from a
"Russian newspaper, which describes in a
"popular way the exhibition of some electric
"lamps made at St. Petersburgh by Messrs. 5260
"S. A. Kosloff & Co. In this description the
"lamps exhibited are referred to as producing
"their light by the glowing of a piece of
"charcoal enclosed in a glass tube, from
"which the air has been exhausted, and
"which had then been hermetically sealed.
"In this document it is manifest that the

5261 "word 'charcoal' is used, not in the popular
"signification of wood charcoal, but in the
"technical electric sense of hard carbon, such
"as is and has been almost from the first used
"in the production of the arc light. This
"appears from the second paragraph of this
"article, which read as follows: 'By the
"'old method the electric spark was passed
5262 "'between two points of charcoal, each at-
"'tached to a copper wire connected with an
"'electro-magnetic machine.'

"I think I can assert with the utmost con-
"fidence that an electric light was never pro-
"duced between points of wood charcoal by
"a current from a magneto-electric machine.
"Long before the magneto-electric machine
"came into use the pencils of hard carbon
"were devised and manufactured, and no one
5263 "would for a moment think of employing
"wood charcoal, which was entirely unfit for
"any continuous maintenance of light with
"these machines, which were specially adapted
"for long continued and uniform operation.
"It is therefore manifest that the writer of
"this article, when he spoke of charcoal
"points for the arc light, meant what we
"should now call hard carbon pencils or
"rods made by the process of Carré or the
5264 "like, and that when he used the same
"word a little further on to describe the
"incandescent conductors of the electric
"lamps used at St. Petersburgh, he meant
"the same thing, and would convey that
"meaning to any one skilled in the art who
"read this paper. Certain it is that there is
"here no mention of any arch-shaped con-
"ductor, and no suggestion that such

"arch-shaped conductor was made out of 5265
"fibrous or textile material, or even out of
"paper, or that any of these materials were
"to be put into an arch form prior to car-
"bonizing. The only feature in common
"between this description and the patent in
"suit is that in both cases incandescent car-
"bon conductors are enclosed in exhausted
"air-tight glass vessels, but this is certainly
"not enough to render this publication in
"any sense an adequate anticipation of the 5266
"patent in suit, with its three prominent
"features of an incandescent conductor made
"of fibrous or textile material, having an arch
"shape, and being enclosed in a vessel wholly
"of glass.

"Taking up, in the next place, the Konn
"patent No. 3,809, of 1872: This patent de-
"scribes an incandescent electric lamp con-
"sisting of a glass lobe or cylinder contain-
"ing a conductor, preferably of graphite, in 5267
"the form either of a straight rod or of a V-
"shaped piece. The glass globe is stated to
"be hermetically sealed and filled with nitro-
"gen or other gas that does not support com-
"bustion. Graphite is described as the pre-
"ferred material for the conductor, and graph-
"ite conductors are alone referred to in this
"patent, and therefore it seems to me that
"this patent contains no suggestion whatever
"as to the employment of a fibrous or textile 5268
"material for the production of an incandes-
"cent carbon, since such material would be
"the very furthest possible removed from
"anything that the name graphite suggests.
"I do not at all agree with Dr. Barker that
"because the inventor says 'preferably graph-

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"ite any intelligent person would understand "that something utterly unlike graphite was "also suggested, but on the contrary, I "should consider that the preference for "graphite indicated rather a preference for "materials which were like graphite, such as "the gas carbons, and artificial carbon pen-"cils, well known at that date. Again, I do
5270 "not understand that a carbon conductor in a "V-form shown in this patent, has any of the "advantages present in the arched form, and "therefore I do not consider carbon conduc-"tors of a V-form referred to in this patent, as "in any way suggesting the arch-form carbons "made of fibrous or textile material charac-"teristic of the invention of the patent in "suit. One of the most important advan-"tages resulting from the arch-form is, that "it secures a perfectly uniform distribution of
5271 "any strain brought upon the conductor by "changes of temperature or any other cause, "and another is, that it involves a uniform "cross-section throughout the conductor, and "another is, that it increases the length of the "conductor without a corresponding increase "in the size of the enclosing vessel. None "of these advantages would exist in the V-"shaped conductor shown in the Konn pat-
5272 "ent, because this conductor would be of very "irregular cross section; any strain brought "upon it would be unequally distributed, and "its increase in length would be quite insig-"nificant.

"I therefore do not find in this patent any "anticipation of the patent in suit, as to the "character or form of the conductor, and

"nothing adequate as to the enclosing vessel 5273
"wholly of glass, since there is nothing in "the Konn patent suggesting this feature.

"Turning next to the De Moleyns patent "No. 9,053 of 1841, I find here described a "structure which seems to me entirely irrele-"vant to the present subject. It consists of "an exhausted glass globe, containing spirals "of platinum wire heated by an electric cur-"rent and an arrangement by which carbon 5274
"in a condition of fine dust may be made to "pour over these coils and glow by heat ob-"tained in falling over them. I believe that "this would be entirely inoperative, and that "the falling of the carbon powder would sim-"ply serve more or less to cut off or extin-"guish the light given by the platinum spi-"rals. But aside from this, it hardly seems "necessary to say that such a contrivance has "substantially no relation whatever to an in- 5275
"vention consisting of an incandescent con-"ductor of an arched form made out of car-"bonized fibrous or textile material and en-"closed in a chamber wholly of glass.

"Finally, among these patents I come to "that of Binks No. 119 of 1853. The Binks "patent may, I think, be easily disposed of "as completely irrelevant, because it de-"scribes no form whatever of incandescent "electric lamp, but only arc lamps and the 5276
"electrodes used therein. Still further, the "only form of purely carbon electrode, even "for an arc lamp, is one formed by subjecting "lignite to destructive distillation in closed "vessels, by which the patentee says he ob-"tains a hard close-grained charcoal. The "patentee also speaks of forming another "sort of electrode by coating metal with tar,

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"pitch, etc., and heating in closed vessels, but "these likewise are used, as the patent plainly "states, for the production of arc lights, and "he also does the like by coating metal with "slips or cuttings of charcoal or charcoal "veneer. The fact that this patent contains "no reference to incandescent lamps of any "sort, would, as it seems to me, dispose of it
5278 "in relation to the present case, but, as Prof. "Brackett seems to think that lignite is not a "mineral, and that therefore the production "of carbon electrodes even for the pencils of "arc lamps, from lignite, has some sort of "reference to the use of fibrous textile mater- "ial for the carbon conductors in *incandescent* "lamps, it may be worth while to mention "that, in the opinion of mineralogists at "least, lignite is a mineral despite the fact
5279 "that like the diamond and all forms of coal, "it is undoubtedly of vegetable origin and "contains more or less traces of its original "structure.

"Referring to Dana's Mineralogy, pub- "lished in New York, 1877, I find on page "395 the general title "Mineral coal" and on "the next page under the same general head- "ing, 'C., Brown Coal, * * * (lignite) "Brown coal is often called lignite, but this
5280 "term is sometimes restricted to masses of "coal which still retain the form of the origi- "nal wood.'

"In a work published by the U. S. Govern- "ment entitled 'Mineral Resources of the "United States, by Albert Williams, Jr., chief "of division of Mining Statistics and Tech- "nology,' I find on page 85 as follows: "Wy- "oming * * * In quality the coal is a "lignite of superior grade".'

5281

"It is unnecessary to multiply such refer- "ences, and I will therefore only say generally "that I find lignite referred to everywhere in "works on mineralogy, and nowhere in works "on botony, which makes me think that it "would not naturally suggest the use of vege- "table fibrous material to the ordinary intel- "ligent artisan.

"I notice another apparent slip or over-
"sight on the part of Prof. Brackett, where, 5282
"in reference to the Binks patent, he speaks "of the thin carbon plates or veneers as being "there described as used for incandescent "lighting. I do not think he could have "read this part of the patent with its context "attentively, or he would have seen that the "'electrodes' produced in this manner were "clearly intended for use in arc lamps, the "only kind anywhere referred to in this pa-
"tent, and that the idea of their preparation 5283
"was the same as that involved in the copper- "plating of arc-light electrodes for arc lamps, "so generally employed at the present day, "viz., the reduction of the resistance of the "electrode by the addition of a copper "conductor, which Binks proposed to put "inside, while in modern practice it is put "outside.

"Aside from all this, however, it is, I think,
"manifest at a glance that the Bink's patent 5284
"is no anticipation of the patent in suit, in so "far as this patent describes the conductor of "an incandescent lamp made of carbonized "fibrous or textile material, of an arc shape, "and enclosed in an air-tight vessel, wholly of "glass."

(Adjournment.)

5285 "At the conclusion of the last session I had
"gone over all the patents referred to by
"either Prof. Brackett or Dr. Barker as con-
"taining the best of their references as anti-
"cipations of the patent in suit. Prof. Brack-
"ett refers also to two publications, one being
"that by Sidot in the *Comptes Rendus*. This
"I find to describe a method of carbonization
"of various materials, including many vege-
5286 "table fibrous substances by enclosing them
"in highly heated tubes through which sul-
"phide of carbon is made to pass. The
"author characterizes the product thus ob-
"tained, in the following words:

"'It may be characterized from a point of
"'view of conductivity as *wood charcoal trans-*
"'*formed into coke.*'

"The only reference to electric light in this
5287 "article is the following:

"The 'pencils made of them give an elec-
"'tric light far more intense than the light
"'obtained with carbons from gas retorts.'

"From all this, it will, I think, appear that
"in this article we have no suggestion what-
"ever as to the use of carbon from vegetable
"fibre or textile material, made into an arc
5288 "form, as the conductor of an incandescent
"electric lamp, but have only information as
"to a method of converting such materials
"into coke, whereby their utility in replacing
"the ordinary arc-light electrodes, generally
"made from gas coke, was set forth.
"Finally, Prof. Brackett refers to a paper

"by Violette, published in the American 5289
"Journal of Science and Arts, in 1853. This
"describes a method of producing a red char-
"coal, specially fit for the manufacture of
"gunpowder by the use of superheated steam.
"Incidentally the author notices that char-
"coal made at a high temperature conducts
"better than the charcoal of gas retorts, and
"serves better for electric illumination. It is
"hardly necessary to state that the electric
"illumination here referred to is arc lighting 5290
"carried on by the use of electrodes of gas
"carbon, and that this article on the prepara-
"tion of charcoal for gunpowder, and its inci-
"dental allusion to the improved conductiv-
"ity of carbon prepared at high temperatures
"and its consequent usefulness for the elec-
"trodes of arc lights, contains no suggestion
"as to the subject matter of the patent in
"suit.

"I have now considered all the publica- 5291
"tions referred to by defendant's experts as
"being the best in the way of anticipations.
"As regards the other references to which
"they have referred in their direct examina-
"tion, I will not spend the time which would
"be necessary in order to consider them in
"detail or individually, but will simply say in
"general terms that they divide themselves
"into two classes, the first consisting in scien-
"tific papers and researches, which, while 5292
"developing a great many interesting facts
"in connection with the properties of carbon
"and other substances in their relations to
"electric currents and the like, do not in any
"way describe, and are not claimed by any-
"body to describe, any such structure or com-

5293

"bination as constitutes the invention set "forth in complainant's patent, and there- "fore, while these references are interesting "as matters of information and to aid in "explanation, they have no force and weight "whatever if considered in the light "of anticipations. The other class consists "of patents which either have no reference at
5294 "all to the subject matter of the patent in "suit, being patents for arc-light regulators, "or the manufacture of electrodes for arc "lamps, or for incandescent lamps with metal- "lic conductors, or arc-incandescent lamps "with conductors of hard carbon developing "properties exactly the reverse of those "called for in the invention of the patent in "suit. As the experts for defendant have "themselves considered these references less
5295 "complete and appropriate than those which "I have recently considered in detail, and as "I have shown that not one of these refer- "ences contains the invention of the patent "in suit or anything like it, it seems to me "that it would be a waste of time to enumer- "ate these inferior references more particu- "larly, and that it will be enough for me to "say that I find them one and all either less "relevant, or quite irrelevant to the invention
5296 "of the patent in suit, as compared with "those which I have above discussed indi- "vidually.

* * * * * * * * *

"25 Q. In the light of our present knowl- "edge, has carbonized fibrous or textile "material, as distinguished from other forms

"of carbon, any peculiar fitness for use as 5297
"the conductor of an incandescent lamp, and, "if so, in what does such peculiar fitness "consist?

"A. In the light of our present knowledge "we know that to produce such an incandes- "cent lamp as has proved itself to be com- "mercially successful, fibrous vegetable ma- "terial possesses special advantages, which "are, first, that it is readily formed or shaped "or may be obtained already formed or 5298
"shaped prior to carbonization, such form- "ing or shaping including the shaping into "an arch form. In the second place, such "material after carbonization lends itself "readily to the treatment known as 'temper- "ing' and 'treating,' whereby its mechani- "cal strength and uniformity of electric "resistance can be readily increased and con- "trolled. Thirdly such material, after car- "bonization, is found to have a very high 5299
"specific electric resistance, which is of great "importance and value in the production of "an incandescent light, although without im- "portance, and, indeed, on the contrary, an "undesirable property in the electrodes em- "ployed for an arc light. Fourthly, conduc- "tors of this material have been found to "possess remarkable properties of mechani- "cal strength, enabling them to resist shocks "and strains to which they may be exposed, 5300
"such strength being combined with an "elasticity which is specially developed and "utilized when their shape is that of the "arch or loop. Fifthly, by the use of such "fibrous vegetable structures it is compara- "tively easy to produce conductors which "initially are of substantially uniform resist-

5301 "ance, such uniformity being due both to "equality of structure and of cross-section "throughout their length, and to the purity "of their material, namely, the absence of "mineral matter, which, being as a rule of "high resistance in comparison with carbon, "would introduce, if present, great irregu- "larity in this respect.

5302 "26 Q. Has carbonized fibrous or textile "material as distinguished from other carbon, "any peculiar fitness for use in arc-light- "ing or in semi-incandescent lamps?

"A. Not taken as a whole. In other "words, some of its distinguishing properties "would peculiarly *unfit* it for these uses and "would more than neutralize any beneficial "effect from such properties as might be ad- "vantageous in arc-lighting. For example,
5303 "it is desirable that the specific resist- "ance of the electrodes should be as small as "possible. If we could make electrodes with "no resistance at all, they would be perfect or "ideal electrodes for this purpose. There- "fore, a high specific resistance is in every "way an undesirable and injurious property. "The capacity of shaping prior to carboniza- "tion is of no practical value in connection "with arc-lights, because the materials used "for these lights are very readily gotten into
5304 "shape, and usually are so shaped while in "the condition of powders already carbon- "ized, or, in other words, while in the con- "dition of carbon powders.

"Their dimensions, also, are such that the "question of mechanical strength is entirely "immaterial, since their size gives them abun- "dant resistance to any shock to which they

"would ever be exposed. Uniformity of resist- 5305
"ance, in the sense or to the degree in which "we consider it in the case of incandescent "conductors, is also entirely immaterial in the "case of the electrodes for arc lamps, in which "such differences, in this respect, as would "be serious in the case of incandescent con- "ductors, are quite immaterial. The advan- "tage coming from a purity in the material is
"one that would have some effect in reference 5306
"to the electrodes for arc lights, but can be "secured in the manufacture of those articles "far more readily than by the use of fibrous "vegetable material, since pure carbon in the "condition of lamp black, or other prepara- "tions, can be readily treated in the manufac- "ture of these electrodes, and will then pro- "duce a product quite as pure as anything "that can be obtained from vegetable fibre.
"As these electrodes are never employed in 5307
"an arch form, of course the capacity of as- "suming such form would have no value in "connection with them.

"27 Q. Aside from low specific resistance, "what is the quality particularly requisite in "arc-light carbons?

"A. Resistance to combustion, or, in other "words, what we may describe as hardness, in "this connection. In other words, an ex-
"treme density, by reason of which, even at 5308
"very high temperatures, the chemical action "of the air can have only a minimum effect "upon the electrodes.

"28 Q. How would carbonized fibrous or "textile material comply with this require- "ment?

5309 "A. Very badly as compared with what "are known as hard carbons, structures such "as those produced from gas coke and the "like. One of the reasons why charcoal was "very early abandoned as a material for the "electrodes of electric lights was just this "fact of its rapid combustion or consumption "by action of the oxygen of the air, and it
5310 "was to escape this that even the very early "experimenters used pencils of gas coke in "place of rods or pieces of wood charcoal.

"29 Q. What sort of carbon would best ful- "fill the requirements of semi-incandescent "lamps?

"A. In this case also a hard carbon, or "just such an one as would be used for arc "lights, because here, likewise, the object "would be to secure a material of very low
5311 "specific resistance and of high chemical re- "sistance, as we may call it, or power of re- "sisting the chemical action of the oxygen of "the air upon the material.

"30 Q. In your answer to question 20, in "what sense did you use the expression 'su- "perior powers of resistance' as applied to "graphite?

"A. I meant in that case what I have just
5312 "called chemical resistance, that is, resis- "tance to combustion or the attack of oxy- "gen.

"31 Q. Would it be practicable in your "opinion, to conduct the modern commercial "business of arc-lighting with pencils made "of the carbonized fibrous or textile material "referred to in the patent in suit?

"A. It would not be. Such pencils would "have far too high a specific electrical resist-

"ance, and far too low a resistance to com- 5313
"bustion.

"32 Q. Would a person skilled in the art "as it stood prior to 1880, or to the making "of the invention described and claimed in "the patent in suit, have been led naturally "from the existing knowledge in regard to "arc-lights and semi-incandescent lamps to "adopt carbonized fibrous or textile material 5314
"as the conductor of an incandescent lamp?

"A. Decidedly not. On the contrary, I "think that the state of the art in this res- "pect would have led him in the opposite di- "rection, and would have indicated to him "that the desirable thing was a carbon pos- "sessing the characteristic properties of what "I have indicated by the term 'hard carbon,' "or such as is produced from gas coke and "like materials.
5315

"33 Q. Assuming that the prior patents "and publications referred to by defendant's "experts contain instructions to make the in- "candescent conductor of an electric lamp "of wood charcoal, would this, in your opin- "ion, be equivalent to, or lead to the same "result as, the instructions contained in the "patent in suit? You may assume for the "purposes of your answer that the instruc- 5316
"tions of the patent in suit are simply to "make the conductor of carbonized fibrous or "textile material?

"A. I do not consider that the instruction "to make the conductor of wood charcoal "would in any way be the equivalent of the "instruction of the patent in suit to make the "conductor of carbonized fibrous or textile

5317 "material, and the following of such instruc-
"tion would lead, I think, to entirely differ-
"ent results. That is, the instruction to make
"the conductor of wood charcoal would cause
"the artisan following such instruction to go,
"as I may say, to the charcoal barrel or char-
"coal bin and select from that material such
"a piece as he might find best suited for his
"purpose. He would then proceed to shape
5318 "such a piece of charcoal in the best manner
"he could, and he would, I think, have great
"difficulty in producing any conductor suffi-
"ciently uniform in electric resistance to be
"available in an an incandescent electric lamp.
"I do not see how under any circumstances
"he could make a conductor having the arched
"form which would be at all available. On
"the other hand, the artisan to whom the in-
"struction had been given to produce the
5319 "conductor from fibrous or textile mate-
"rial would naturally and at once seek out
"among the uniform fibrous or textile mate-
"rials such as appeared suited for the pur-
"pose; namely, as I have already pointed out,
"he would take pieces of cotton or linen thread
"or of grass-like or reed-like materials, such
"as he would be familiar with as used in tex-
"tile structures. These he would find it easy
"to shape into conductors which, on carboni-
5320 "zation in the usual manner, would be sub-
"stantially uniform in electric resistance,
"and nothing would be easier than the shap-
"ing of such material into an arched form.
"Therefore it seems to me that the instruc-
"tions referred to would be entirely different,
"and would lead to results radically unlike

5321
"34 Q. Professor Brackett states in his an-
"swer to question 5 that the advantages of
"the arch or horseshoe form of incandescent
"conductor are present whatever may be the
"material, whether it is a metal or carbon.
"Are you of the same opinion?
"A. I do not at all agree with Professor
"Brackett, but, on the contrary, feel confi-
"dent that the advantages of the arch form
"would only be fully or adequately realized
"in such a material as the patent in suit indi- 5322
"cates, namely, carbonized fibrous or textile
"material. Thus, for example, if the con
"ductor were of metal, its natural flexibility
"and elasticity would be such as to allow it
"to bend or change its form without injury,
"even if it were not originally made into an
"arch-shaped form, and therefore the bene-
"ficial effect of the arch form as relieving the
"strain would not be utilized or realized. On
"the other hand, if the material were hard 5323
"carbon, then, on account of the brittleness
"of that substance, the strains produced by
"expansion might be likely to cause fracture
"in the arch form quite as much as or more
"than in the form of a straight pencil, be-
"cause in the case of a straight pencil the
"expansion and contraction would force a
"yielding or movement on the part of the
"supports, and would be equally distributed
"through the conductor; whereas when this 5324
"conductor was in an arched form the same
"strain would have more tendency to rupture
"the arch than it would to move the supports
"in the previous case. If, however, the ma-
"terial were such carbon as is produced
"by the carbonization of a fibrous or textile
"material, then this material, having in itself
"considerable elasticity and flexibility, would,

5325 "if made into an arch form, so yield that the "strains produced by heating and cooling "would be equally distributed, and produce "no injurious effect such as would result "with the same material if it were not in an "arched form, when its flexibility would be "likely to result in a buckling or sudden "bending at a single point or a few points,
5326 "by which excessive strain would be devel- "oped at those points, and tend to cause frac- "ture. It is, therefore, my opinion that the "valuable results obtained from the arched "form, so far as the question of distribution "of strain is concerned, would only be ade- "quately realized by the fibrous material indi- "cated in the patent, and not either by a "metallic conductor or one made of hard "carbon.

5327 "35-36 Q. Do you agree with the opinion "expressed by defendant's experts that the "advantages of the arch form in providing for "expansion and contraction are not present "in the lamp described in the patent in suit, "but that the conductor there shown and "described is as liable to fracture in the arch "form shown as it would be in the form of a "straight rod or pencil?

5328 "A. I do not agree with them, if it is "understood, as of course it should be, that "the material of the conductor shown in the "patent is the carbonized fibrous material. "In that case, even in the form shown in the "patent drawing, such material would have "sufficient elasticity to derive beneficial ef- "fect from the arched form as there shown. "Of course I do not understand that the pa- "tent in its description at all confines itself to

"what I may call so low an arch as that 5329 "shown in the drawing. On the contrary, "the patent itself speaks of this arch as being "of an arch or horseshoe shape, and also as "being an arch or loop.

"37 Q. Do you agree with Prof. Brackett "in the opinion expressed by him in answer "to question 35 that in the modern incan- "descent lamp the advantages arising from "the capacity of the conductor to contract "and expand without breaking or disturbing 5330 "the position of the fixed terminals, would "be present whatever the form of the con- "ductor, whether that of a loop or of a "straight piece?

"A. I do not. On the contrary, I feel "sure that if, in a modern lamp, the conductor "were arranged in a straight piece, it would "be very liable to be broken, because on ex- "panding it would be liable to buckle or bend "substantially at one point, or on shrinking 5331 "be subjected to a strain which would frac- "ture it by tension.

* * * * *

"40 Q. Was the liability of the carbon con- "ductor to fracture from the effects of ex- "pansion and contraction a recognized de- "fect of the incandescent lamps having "straight carbon conductors, which were "known prior to 1880?

"A. It was; and means of correcting this 5332 "defect are set forth in some of the patents "which have been referred to.

"41 Q. What kind of means?

"A. Arrangements as to the supports of "the ends of the conductors, by which these "were made to yield so as to accommodate

5333 " themselves to changes in length of the con-
" ductor.

" 42 Q. Do you know of any incandescent
" lamps used since 1880 having straight car-
" bons, V-shaped carbons, or carbons of any
" shape except the arch shape or some modi-
" fication of it?
" A. I know of none except such as
5334 " would come within the description of modi-
" fied arch shape; such, for instance, as the
" Maxim lamps which were made with a pa-
" per carbon having the general shape of the
" letter 'M,' but so constructed that there
" were actually three arches in the conductor,
" the bends being rounded or arch-shaped.

" 43 Q. Do you agree with Prof. Brackett
" in the opinion expressed in his answer to
" question 6, and Prof. Barker in the opinion
5335 " he expresses in his answer to question 14,
" that the arch or horseshoe shape described
" and claimed in the patent in suit was old in
" carbon? Please consider in this connec-
" tion Prof. Brackett's answers to questions
" 5 and 9, and Prof. Barker's answers to cross-
" questions 64 and 65?
" A. I do not agree with these gentlemen.
" The only reference that either of them is
5336 " able to cite is that of the Konn patents, in
" which there is described a carbon conductor
" in a V-shape, the V-shape shown in the
" drawing being a very low or flat 'V,' that
" is, having a very wide angle at the apex, and
" of irregular cross-section. This I do not
" think in any way even approaches the sug-
" gestion of an arch shape, or if it were follow-
" ed would produce a conductor having any

" of the beneficial properties resulting from 5337
" such arch shape. In addition to this state
" of affairs, which appears from the drawing,
" the Konn patent No. 3,809 states that the
" light is formed at the angle at the bottom
" of the 'V'. This would indicate either that
" the cross-section of the 'V' was extremely
" irregular, or that in some way there was a
" special resistance at this point by reason of
" which the light was there locally developed,
" and of course any such conditions would be 5338
" inconsistent with the beneficial effects ob-
" tainable from an arched shape, such as is
" indicated in the patent in suit.
" 44 Q. Do you agree with Mr. Edison
" in the opinion he expresses in his answers
" to questions 432 and 467 to 470 inclusive,
" that while the quality of high specific resis-
" tance possessed by carbonized fibrous or
" textile material is advantageous for lamps
" of high resistance, it is not advantageous 5339
" but rather the reverse for incandescent
" lamps of comparatively low resistance?
" A. I do not at all agree with this state-
" ment, and was very much astonished when I
" first read it in Mr. Edison's deposition, and
" feel convinced that he could not have given
" much thought to what he was saying when
" he made this answer. In any system of
" electric lighting by incandescence it is de-
" sirable that as much of the resistance of the 5340
" entire circuit as possible should be concen-
" trated in the incandescent conductors of the
" lamp. Where these lamps are to be
" employed in parallel arc, it is important
" that the total resistance of each lamp should
" be very high, but when the lamps are used
" in series, it is desirable that the total resist-

5341 "ance of each lamp should be relatively low.
"But, since the production of light must in
"all cases be proportional to the product in-
"volving the resistance as one factor and
"the current as another, it is manifest
"that the specific resistance must in
"either case be high, in order that there
"should be enough of it in a moderate length
5342 "of the conductor to develop from the cur-
"rent employed the light energy which is de-
"sired. If, as Mr. Edison states, a high
"specific resistance was undesirable in an in-
"candescent lamp when used in successive
"series, then, of course, such lamps might
"readily be made, by the use of good con-
"ductors such as the ordinary arc light elec-
"trodes. The actual fact is that a high
"specific resistance is desirable in either form
5343 "of lamp, and all that can truly be said in
"this regard as to difference, is that it is more
"important in order to meet certain mechan-
"ical conditions in the case of the lamps run
"in parallel series, than it is with the lamps
"run in successive series. So far, there is a
"difference, but this is simply a difference of
"degree, and does not authorize any such
"broad statement as that which is contained
"in Mr. Edison's answers referred to.

5344 "45 Q. As a matter of fact what sort of
"carbon is used in series lamps of relatively
"low total resistance which are in commercial
"use at present?

"A. Exactly the same kind of carbon as is
"used in the lamps of high resistance, the
"difference being that the conductors are
"made shorter and thicker in the lamps of
"low resistance, and longer and thinner in the
"lamps of high resistance.

"46 Q. Is it hard carbon or carbonized 5345
"fibrous textile material?

"A. Carbonized fibrous or textile material.

"47 Q. Please read Prof. Cross's answer
"to question 33, and state whether or not
"you agree with him in the opinion he ex-
"presses that none of the prior patents and
"publications put in evidence by the defend-
"ant describe or show the lamp-structure of
"complainant's patent in suit, or any equiva- 5346
"lent for it.

"A. I entirely agree with Prof. Cross in
"this answer, and, as I have already pointed out
"in great detail, I find in none of the patents
"or publications referred to by defendant's
"experts, except, of course, in the prior pat-
"ents of Sawyer and Man referred to in the
"patent in suit, this part of the combination
"or invention set forth in that patent.

"48 Q. Do you agree with the opinion ex- 5347
"pressed by defendant's experts that the lamp-
"structure of the complainant's patent in suit
"has all the defects of the lamp structures of
"incandescent lamps described in the prior
"patents and publications in evidence, and
"that the said lamp-structure would be wholly
"unsuitable for making a practically useful
"lamp for the purpose of electric illumination,
"and, moreover, that the low resistance of the 5348
"incandescent conductor described in com-
"plainant's patent would make the lamp prac-
"tically useless.

"A. I do not agree with this opinion, but
"on the contrary consider that the lamp-
"structure of complainant's patent, by reason
"of its consisting wholly of glass, avoids
"serious defects found in previous structures,

5349 "and is capable of producing a practically
"efficient incandescent electric lamp.

"49 Q. Would it in your opinion be prac-
"tically useful for any commercial purpose,
"and how would it in your opinion compare
"with such lamps as are described in the
"prior patents and publications put in evi-
"dence?

"A. It would undoubtedly be useful for com-
5350 "mercial purposes at the date of its inven-
"tion, though of course it might not compete
"at the present day with the improved lamps
"now made. It would, I have no doubt, be
"very superior to any of the lamps made or
"described prior to the date of complainant's
"patent, though some of these, I believe, ac-
"tually met with a certain amount of com-
"mercial success. Thus, for example, in the
5351 "work entitled 'Electric Lighting, by Hyp-
"polite Fontaine,' translated from the French
"by Paget Higgs, London, 1878, I find, on
"page 171, a reference to the Lodyguine lamp,
"and to certain improvements made there-
"upon by Mr. Konn, also of St. Petersburg.
"On page 174, in reference to these the fol-
"lowing statement occurs:

"'Three of these lamps were introduced
"'two years ago at the house of M. Florent,
5352 "'a merchant of St. Petersburg, and put in
"'action with an 'Alliance' machine. Each
"'carbon lasted about two hours with the ex-
"'ception of the first, which is consumed
"'nearly immediately; the light is very agree-
"'able, but its cost considerably exceeds
"'that of gas. M. Florent, whom we have
"'had occasion several times to see, has in-
"'formed us that the great advantage he has

"'found in the employment of electric light- 5353
"'ing was its cleanliness. His storerooms
"'contained much white linen that gas rapid-
"'ly impairs, and on which electricity exer-
"'cises no injurious influence. The bleach-
"'ing economized fully compensates the sup-
"'plementary cost necessitated by an import-
"'ant introduction with but little regard to
"'the light obtained.'

"It is manifest from this, that if a lamp in 5354
"which the carbon only lasted two hours had
"a commercial value at this time in St. Peters-
"burgh, a lamp such as that described in com-
"plainant's patent, which undoubtedly would
"last for 100 or 200 hours would, under like
"conditions, have very much greater commer-
"cial value, and I see no reason why with the
"exercise of ordinary ingenuity and experi-
"ence such as any workman acquires in the 5355
"construction of apparatus, lamps such as
"those described in complainant's patent
"should not be made to last many times as
"long as I have indicated.

"50 Q. Do you agree with the opinion ex-
"pressed by defendant's experts that the in-
"ventors, Sawyer and Man, made no substan-
"tial advance in the art, or at least none that
"is shown and described in the patent in
"suit?' 5356

"A. I do not. On the contrary I think
"that they made a very important contribu-
"tion to the state of the art, this contribu-
"tion consisting in the introduction of a lamp
"having its carbon conductor made of fibrous
"or textile material, of an arch shape, and
"enclosed in an air-tight vessel constructed
"wholly of glass.

5357

"51 Q. Do you agree with defendant's ex-
"perts that in view of the prior patents and
"publications put in evidence by defendant
"there is no patentable novelty in the inven-
"tions referred to in the first, second and
"fourth claims of the patent in suit?
"A. I do not. On the contrary I think
"that those patents and publications show
"that the state of the art was far from an-
5358 "ticipating the inventions of this patent, and
"was really going in an opposite direction,
"and, so far from suggesting the combina-
"tions involved in this patent, rather sug-
"gested an opposite and different develop-
"ment which would have led away from the
"results here secured. As regards the first
"claim, there was nothing in the state of
"the art suggesting the production of an
"incandescent conductor for an electric
5359 "lamp made from carbonized fibrous or tex-
"tile material in any shape, and certainly
"not in an arch or horseshoe shape. Hav-
"ing reference to the second claim, there
"is nothing in the state of the art showing
"the combination of an incandescing conduc-
"tor of carbonized fibrous material enclosed
"in a transparent, hermetically-sealed cham-
"ber; and, as regards the fourth claim, there
"is nothing in the state of the art show-
5360 "ing the combination of a chamber made
"wholly of glass from which all carbon con-
"suming gas has been exhausted or driven,
"electric conductors passing through the glass
"walls of said chamber and hermetically sealed
"therein, and an illuminating conductor con-
"sisting of carbon made from a fibrous or tex-
"tile material having the form of an arch or
"loop.

5361

"52 Q. Do you agree with the defendant's
"experts, that the material and the form of the
"burner of the first claim are entirely inde-
"pendent of each other?
"A. I do not. On the contrary, as I have
"already pointed out, I consider that the
"material and form are two elements which,
"acting together, produce a novel and useful
"result which would not be obtained or availed
"of where either of them existed separately. 5362
"That is, the arch form would be of little or
"no value if the conductor were of metal or
"of hard carbon, and the fibrous or textile
"material would be of much less utility if
"employed in a conductor not having the
"arch form.

"53 Q. Do you agree with defendant's ex-
"perts that there is no combination between
"the particular kind of burner referred to in 5363
"the fourth claim, and the enclosing chamber
"made entirely of glass, referred to in the
"same claim?
"A. I do not. On the contrary, I consider
"that hereby we get a result by the concor-
"dant action of two elements, which result
"requires for its development the united
"effect of both elements. Thus the conductor
"of fibrous material here described, in order
"to render available the special advantages 5364
"which it possesses, must be protected very
"thoroughly from the access of air, and
"therefore must be enclosed within a cham-
"ber wholly of glass, by which means alone
"such thorough protection would be attain-
"able.

* * * * * * * *

5365 "71 Q. Prof. Barker, in answer to question
"50, says that the reference to electric light
"in the Gaudain patent, in his opinion, in-
"cludes the incandescent light, as well as the
"arc light, as both forms were well known at
"that time. Do you agree with him in this?
"A. I do not at all agree with Dr. Barker,
"because, though it is true that some incan-
"descent electric lamps had been made and
"exhibited as early as 1876, the art had cer-
5366 "tainly reached no such development as
"would warrant its being referred to in the
"manner found in this patent. The words
"of the patent are 'for the manufacture of
"'pencils for electric lighting.' This would
"clearly and directly convey the idea that the
"electric lighting referred to was a well-known
"commercial business. This was true, at the
"date named, of arc lighting, but not at all
5367 "of incandescent lighting.

"72 Q. What sort of carbon would be pro-
"duced by the process described in the Gau-
"duin certificate of edition of April 7th,
"1877, and would it, in your opinion, be
"substantially the same as the carbonized
"fibrous or textile material of the complain-
"ant's patent in suit?
"A. The words of the patent referring to
5368 "this matter are as follows:

"'I convert this wooden object into a hard
"'and compact carbon, conserving its primi-
"'tive form by drying it, suitably impreg-
"'nating it with tar, pitch, bitumen, resin,
"'essence and oils of coal, in carbon of hy-
"'drogen, sugar, caramel, or other matters pos-
"'sessing analogous properties. I distill it

"'slowly, so as to expel the volatile bodies; 5369
"'I impregnate it anew and re-distill it as
"'many times as necessary, and finally heat
"'it to a high degree of temperature in a re-
"'ductive atmosphere.'

"The product produced in this way would be
"substantially hard carbon, such as was used
"from an early period for the electrodes of
"arc lights, and would have in it nothing pe- 5340
"culiar to, or characteristic of, the wood
"from which it was only in small part
"formed. It would certainly have none of
"the properties which would characterize the
"product of complainant's patent, namely a
"carbon conductor made from vegetable, fi-
"brous or textile material.

* * * * * * * *

"75 Q. Do you, upon looking over your
"deposition, desire to make any explanation 5371
"or correction of any part of it, and if so,
"please make such statement as you desire
"to make in this regard?
"A. In looking over my deposition, I noticed
"a statement in answer 34 that, while correct
"in view of what I had in mind in making the
"answer, may not be correct in reference to
"other considerations which did not occur
"to me at that time. What I refer to is con-
"tained in the following words: 5372

"'On the other hand, if the material were
"'hard carbon, then, on account of the brit-
"'tleness of that substance, the strains pro-
"'duced by expansion might be likely to
"'cause fracture in the arch form quite as
"'much as, or more than, in the form of a
"'straight pencil, because in the case of a
"'straight pencil the expansion and contrac-

5373 "'tion would force a yielding or movement "'on the part of the supports, and would be "'equally distributed throughout the con- "'ductor; whereas, when this conductor was "'in an arched form, the same strain would "'have more tendency to rupture the arch "'than it would to move the supports in the "'previous case.'

5374 "When making this statement, I was regarding the problem as one of a straight "column, or beam, under compressive strain, "as compared with a bent column, or beam, "under like strain, and, under such conditions, "what I have stated would be correct: but "if the actual problem is one in which, as "compared with the column or beam, which "in this case represents the conductor, the "supports are substantially unyielding, and 5375 "therefore the beam or column must change "its form under the applied stress to a limited "degree; in that case, I think that the arch "form would be less liable to break than the "straight bar, even though the material of "which it were made were as rigid and brittle "as the ordinary hard carbon, but, of course, "the advantage secured by the arch form "would be much less with a brittle material "than with a more tough and flexible one. 5376 "The last condition is that which I think would "be controlling in the case of such lamps as we "are now considering; and therefore, taking "everything into consideration, I think that "the arch form would have some advantage "over the straight bar, even with a conductor "made of hard carbon.

* * * * *

"98 x-Q. You have stated in answer 6, in 5377 "in substance, that defendant's experts as- "sume that for a practicable incandescent "lamp, an extremely fine or thin fibre is es- "sential, but that you think that modern "practice in electric lighting shows that a "very fine fibre is by no means necessary or "desirable. In support of this position you "refer to certain low resistance lamps, viz.: "the Edison 'Municipal' lamps, lamps used "in the Heissler system, and the complainant's 5378 "exhibit Thomson-Houston lamp and Bern- "stein lamp, all of which lamps you say are "used in successive series. How long have "low-resistance lamps of the character men- "tioned by you been commercially manufac- "tured and used, so far as you know?

"A. I think that I saw some of these low- "resistance lamps at the Franklin Institute "Electrical Exhibition about five years ago.

"99 x-Q. That was the beginning, as I un- 5379 "derstand you, of their commercial manufac- "ture and use, as you recollect it?

"A. As far as my personal knowledge and "recollection goes, it was.

* * * * *

"101 x-Q. In answer to question 14 you "state that the hydro-carbon treatment, you "believe, is not universally used. What fact "had you in mind in making that statement? 5380

"A. It has been stated to me that the Edi- "son Company, in this country, did not use "that treatment, although they employed it "abroad, and I have also been informed that "the United States Company only applied it "to a portion of their lamps.

5381

"102 x-Q. Is the hydro-carbon treatment, "referred to by you, the treatment described "in the patent of Sawyer and Man, No. 211,- "262?

"A. It is substantially.

* * * * *

74 x-Q. (continued.) Did you give this testimony, and do you still hold the opinions therein expressed?

5382 A. I did give this testimony, and still hold the opinions which I therein expressed.

75 x-Q. Do you recollect the paper entitled "Some "Electrical Measurements of one of Mr. Edison's "Horseshoe Lamps, by Henry Morton, Ph. D., Alfred "M. Mayer, Ph. D., and B. F. Thomas, A. M., at the "Stevens Institute of Technology," published in *The Scientific American*, and republished in *The Telegraphic Journal* for May 1, 1880, pp. 151, 152, which I now hand you?

5383 A. I do.

76 x-Q. Do you recollect the fact of these measurements, and if so are they correctly stated in the publication referred to? Also do you recollect the fact of the publication of this paper, as stated in my last question?

A. I recollect the experiments and believe that their general results are correctly stated in the copy shown me. A more complete account of the same experiments was published shortly afterwards in The Annual
5384 Report of the U. S. Lighthouse Board and elsewhere.

77 x-Q. Do you also recollect the corrections and explanations of this article published in *The Telegraphic Journal* for May 15, 1880, p. 178?

A. I do.

Counsel for Complainant offers in evidence the papers referred to in the last three questions, and the same are marked Complainant's Exhibit, "Dr. Morton's Published Test of an Edison Horseshoe Lamp."

Re-direct examination by Mr. Curtis: 5385

78 R-d Q. Please supply the context of the article in *Scribner's Magazine* immediately following the part quoted in 74 x-Q?

A. Beginning at the opening of the paragraph, the few first words only of which have been quoted, I find as follows:

"This was the state of affairs even up to 5386
"the Fall of 1878, when, as is claimed, Mr. "Wm. E. Sawyer, in combination with Mr. "Albon Man, after many preliminary experi- "ments, produced their first successful incan- "descent lamp with an arch-shaped conductor "made of carbonized paper. In their appli- "cation for a patent, filed January 8, 1880, "these inventors used the following remark- "able language in their fourth claim: 'An in-
"candescing arc of carbonized fibrous or tex- 5387
"tile material.' This indicates that they "realized the importance of what seem to "be the common features of the present elec- "tric incandescent lamps, namely, the arc or "arch or bow or loop form, and the carbon- "ized fibrous or textile material. They also "specially refer to carbon incandescent con- "ductors made from paper."

79 R-d Q. What were the general causes, as you un- 5388
derstand it, which prevented the King, Roberts, Konn and other incandescent lamps with carbon conductors, prior to 1879, to which you have referred in the Scribner article and in your testimony in the McKeesport case, from coming into commercial use?

A. These causes may be classified under the following general heads.

5389 (1) Costliness of electricity.

(2) Imperfection in what may be called the art of producing and maintaining a perfect vacuum.

(3) Imperfections in the art of producing carbon conductors.

(4) Imperfections in the methods of distributing and regulating electric currents, and in a multitude of details, which, through individually of relatively small effect, are collectively of vital importance for the
5390 successful commercial application of electricity as a source of light.

Considering these subjects more in detail :—

(1) The costliness of electricity until the development of dynamo-electric machines, which began about 1875, needs no special explanation. It is enough to say that if to-day we had no cheaper means of producing electricity than was employed by these early experimenters, any commercial application of electricity for incandescent lighting would be entirely out of
5391 the question.

(2) As to the art of producing and maintaining a complete vacuum, it is to be remarked that, while the Torricellian method might, under certain conditions, have been relied upon to produce, in individual cases, a very thorough vacuum, yet the method was, in the first place, not adapted for such extended use as would be necessary in the manufacture of the lamps for commercial use; and it was not till a date subsequent to the description of the King, and I think, the Roberts
5392 lamp, that the invention of the Geissler and of the Sprengel pumps supplied this deficiency. Then again, even with these pumps, the high vacuum, after being made, would not have been preserved adequately, unless the exhaustion during heating, first applied in connection with incandescent lamps in 1878, had been applied. And, in the same connection, it should be noticed that valuable contributions were made by Prof.

Crookes, in 1875 and 1876, to this art of producing 5393
high vacua.

(3.) As to the art of producing carbon conductors, at the time of the King patent, little or nothing was known on this subject. But gradually the work of Carré, Gaudoin, and Sidot contributed important elements in this direction, resulting in the production, on a commercial scale, of carbon conductors of uniform structure, and of small cross-section. But a more important contribution to this art was made when, in
1878, Sawyer and Man applied what is known as their 5394
hydro-carbon treatment to carbon conductors, and a still more important contribution was made when, about the same time, they introduced carbon conductors made from vegetable fibre or textile material.

(4.) As to the various and almost countless improvements or developments in the art of distributing electricity and in the various appliances involved in its use, it would take a long time even to enumerate them; and it will, I think, suffice, at the present time, to say
that, if deprived of them to-day, the art of electric 5395
lighting, though it otherwise included all that was known up to and including the publication of the Herald article of Dec. 21, 1879, would be inadequate to achieve any practical or substantial commercial success.

80 Red Q. How far had these obstacles to the commercial use of incandescent lamps been removed by the development of the art prior to 1879?

A. As the costliness of electricity, very great im-
provements had been made by the inventions of 5396
Gramme, Siemens, Weston, Brush and others, although room was left for considerable improvements which have been since effected.

As regards the art of producing and maintaining perfect vacua, this had been carried to a point of practical efficiency, although here, too, something was left

5397
for subsequent improvements which have been made during the last ten years.

As to the production of carbon conductors, a great advance had been made, although here I do not think that the art had reached the stage which was required for the complete practical commercial success of an electric lighting system.

As to the methods of distribution and improvements in detail, such as those to which I have referred as essential to the present commercial success of electric
5398 lighting, little or nothing had been done, although the general principles involved in these matters were already established and generally known.

In other words, though the art had been developed to such an extent that, by utilizing, for example, the improved carbon conductors of Carré, or, better yet, the fibrous, or textile-material carbons of Sawyer and Man, and by applying to these the treatment for the removal of occluded gases, and the hydro-carbon treatment of Sawyer and Man, individual incandescent
5399 electric lamps could be made which would operate efficiently, and have considerable endurance, yet it would not have been possible to manufacture them with sufficient economy and uniformity, or to so use them as to render them of general commercial value, or in any degree able even to approach the point of competing with gas as means of illumination.

81 R-d Q. What was the issue involved, as you understood it in the suit of the Consolidated Electric Light Co. against the McKeesport Light Co., in which
5400 you gave the testimony quoted in your cross-examination?

A. It was an invention the principal or central feature of which was the employment, as the light-giving conductor of an incandescent electric lamp, of carbon produced from vegetable fibrous or textile material; such carbon being in the form of an arc or arch, and enclosed in a vessel entirely of glass, from which

all gaseous matter capable of attacking said 5401
carbon conductor had been removed and was excluded. Of the elements enumerated above, I regarded the first, or incandescent conductor made from carbonized vegetable fibrous or textile material, as the most important both by reason of its novelty and practical efficiency. Next to this was the arc or arch form; and lastly, the enclosing vessel entirely of glass.

82 R-d Q. In your testimony in that case, in discussing the sufficiency of the specification of the Sawyer 5402
and Man patent upon which the suit was brought, what standard of utility did you assume for the lamp described in the patent?

A. Such utility as would be necessary to render the combination patentable—in other words, what might be called technical or patentable operativeness; or in other words, such a condition of affairs as would render the construction of individual lamps possible, and would secure their capacity to operate, as sources of light, for such a time, and in such a way, as would fit 5403
them for some uses—even though such uses might be very limited or restricted. I did not assume as a standard any such utility as would be requisite in electric lamps which should successfully compete with gas, or even reach such a moderate degree of general application as has been secured by electric lamps at the present date. The position which I assumed is, I think, made very plain from a portion of my answer to direct question 6, found in the lower part of p. 1231, Vol. 2 of complainant's testimony and exhibits 5404
in that case, where, in pointing out what I consider to be the erroneous position of certain experts on the other side, I say: "They also seem to assume that, in order to be practically useful, an incandescent lamp must be able to compete successfully, in cost and convenience with illuminating gas, and even to rival the improved incandescent electric lamps of the present day."

5405

83 Rd Q. Please explain the circumstances under which you made the statements contained in the article in The American Gaslight Journal, the article in The Sanitary Engineer, and the interview in The New York Times, put in evidence by complainant's counsel on your cross-examination, and state what standard of usefulness or efficiency you had in mind in making the statements referred to in regard to incandescent lighting in general, and particularly in regard to the lamp described in The Herald article of December 21, 1879?

5406 A. The standard of efficiency which was then under consideration, as will presently appear, was, in general terms, such as would secure the all but immediate replacement of gas as an illuminant, by electricity, and would involve the supplying of electric light at a price many times less than that at which gas could be furnished, and the manufacture of electric lamps at a cost which would approach that of ordinary gas-burners. To explain the situation clearly I should state that, early in October, 1878, great publicity, through
5407 the daily press, was given to the announcement of a great invention or discovery by Mr. Edison of a method of producing light by electricity, so economical and efficient that its immediate substitution for illuminating gas was a foregone conclusion. As an illustration of this I will quote a few brief extracts.

Thus in the New York *Evening Post* of Nov. 12, 1878, appeared an article headed,

"WHAT EDISON IS ABOUT.

5408 THE ELECTRIC LIGHT AN ACCOMPLISHED FACT.—

Only waiting for the European patents.—

Facts about its cost and management."

This article concludes as follows:

"I judge, then, from these remarks of a "gentlemen eminently qualified to speak on "the subject by his professional knowledge

"of the subjects involved and his personal "intimacy with Edison, that the electric light "as an interior illuminator, filling the place "of oil and gas, is a sure fact in the near "future. My informant scouted the idea "that Edison had been used by speculators "to effect the gas stock market. He believed "these stocks would temporarily recover "from the present panic, but there was no "question as to the genuineness and the en-"tire success of the new light. "H. R. E." 5410

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Again in the New York *Sun*, Nov. 25, 1878, in an article headed "The New Electric Lights," I find as follows, (beginning with the third paragraph):

"The downfall in gas stocks has been "followed by a corresponding increase in "the price of shares of the Edison Com-"pany. It is understood that 260 has been "offered and accepted. The men at
"Menlo say that they are told that the stock 5411
"of a prominent gas company was recently "offered by auction at Nicolay's in Wall "street. The highest bid was 70. The "shares were withdrawn.

"On receiving this information the writer "said that a well informed Wall street gentle-"man thought the purchase of gas stocks was "the best investment that a moneyed man "could make at this time. He thought they
"had touched bottom, and would rapidly come 5412
"to the surface under the influence exerted "by the printed opinions of Prof. Morton and "other savants. Morton's articles had excited "grave doubts as to the utility of Mr. Edison's "invention. But even supposing that the "Edison idea was practicable, there was

5413 — "always a chance that the inventor might die "and his invention relapse into obscurity for "lack of development."

"Mr. Edison tore a soiled silk handkerchief "from his neck and laughed outright.

"'Has this Wall street gentleman any "'money?' asked one of his assistants.

"'I don't know,' was the answer, 'why do "'you ask?'

5414 "'Because if he has any money and backs "'up his opinion with it, he's sure to lose it,' "he said."

I do not make these quotations with any idea at all of suggesting that Mr. Edison was in any way connected with the speculative uses that were being made of this matter, but only to recall distinctly what was the condition of the daily press at the time on this subject. And I may mention, in passing, that the Wall street
5415 gentleman referred to was and is well known to me, and that he did not lose his money, and that, as a matter of fact, I was, at this time and subsequently, frequently appealed to, both personally and by letter, by those interested in gas stocks, so that I know, of my own personal knowledge, that such publications as I have referred to produced a very considerable effect. My knowledge also as to the actual claims made by Mr. Edison and his friends, at this time, was not confined to matter published in the daily press.

5416 Adjourned till Tuesday, March 11, at 10 A. M.

NEW YORK, March 11, 1890. 5417

Met pursuant to adjournment.

Present counsel as before.

Witness continued as follows:

In my conversation with the *Times* reporter, which appeared in the New York *Times*, Dec. 28, 1879, and which has been introduced as an exhibit in this case, I used these words:

"In turning over some old letters, a few "days since, I came across one from a friend 5418
"of mine, who is a scientific man of high "standing, and was at that time on very in- "timate terms with Mr. Edison. This letter "is dated Oct. 21st, 1878, and in it I am as- "sured that Mr. Edison's lamp is a perfect "success, capable of replacing a gas-burner, "and that when I see it, I shall, no doubt, be "charmed with its simplicity and efficiency. "When I reflect that this previous complete "success has been since abandoned by Mr. 5419
"Edison, I feel that a little caution is needed "in accepting the enthusiastic conclusions of "his friends, even when they are illuminated "by the shining electric lamps which occa- "sioned them."

The letter above referred to I have now before me, and will quote the portion relevant to this subject, the rest of it being about lecture-experiments, Jablochkoff candles, and other matters of no present interest: 5420

"I think you will be surprised when Edison "makes public his new light. I am not sur- "prised after his telephone experiences, that "he declines to make it public until his for- "eign patents are secured. He has, by an "exceedingly ingenious contrivance, produced "an electric burner which can in every way

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"replace the ordinary gas-burner. As you
"very properly say, there are many details
"yet to be arranged before the thing can be
"put in practice. The new burner, however
"I know will please you.

"Cordially yours,

"GEORGE F. BARKER."

About ten days before, I had received from Mr. Edison himself the following letter:

5422 "T. A. EDISON.

MENLO PARK, N. J., Oct. 10, 1878.

PROF. HENRY MORTON, Hoboken.

"DEAR SIR—Your favor of the 9th has just
"been received. The *Sun* article was *some-*
"*what* exaggerated, but it is safe to say that
"I have some new ideas in regard to the elec-
"tric light, more especially relating to the in-
"finite subdivision of the same. I expect to
5423 "put in at least 6 months' solid work perfect-
"ing it. Am just ordering a 50 H. P. engine
"for this line of experiment.

"I do not think I will enter the lecture field
"for several years—can't spare the time, and
"have no inclination that way.

"Very truly yours,

"T. A. EDISON."

The *Sun* article referred to in this letter is the one
5424 which has already been introduced in this case as it
was republished in the London *Telegraphic Journal* of
Oct. 15, 1878, pages 414 and 415, in which I find such
statements as the following:

"With the process I have just discovered,
"I can produce 1,000—aye, 10,000—from one
"machine. Indeed the number may be said
"to be infinite. When the brilliancy and

"cheapness of the lights are made known to 5425
"the public—which will be in a few weeks, or
"just as soon as I can thoroughly protect the
"process—illumination by carburetted hydro-
"gen gas will be discarded. With fifteen or
"twenty of these dynamo electric machines,
"recently perfected by Mr. Wallace, I can
"light the entire lower part of New York
"City, using a 500 horse power engine. I
"propose to establish one of these light-cen- 5426
"tres in Nassau St., whence wires can be run
"up town as far as the Cooper Institute,
"down to the Battery, and across to both
"rivers."

And again at the conclusion of the article, I find as follows:

"It has been computed that by Edison's
"process the same amount of light that is 5427
"given by 1,000 cubic feet of the carburetted
"hydrogen gas now used in this way, and for
"which $2.50 to 3 dollars is paid, may be ob-
"tained for from 12 to 15 cents."

These various extracts will show what was claimed for
the Edison discovery in 1878. Between this time and
the publication of the *Herald* article of Dec. 21, 1879,
it gradually became known to me and others that the
invention about which all these wonderful things had 5428
been said, was neither more nor less than that involved
in the use of platinum wire, with the more or less com-
plicated attachments figured and described in the same
Herald article, which besides being anticipated by the
experiments of Dr. Draper, Mr. Farmer, and the patent
of Maxim, to say nothing of earlier records, was, in
effect, acknowledged as a practical failure in the same
Herald article, and abandoned by Mr. Edison as a

5429 means by which his enthusiastic early promises might be fulfilled. In place of all this, the *Herald* article presents as the subject for a new departure, and the foundation for a new speculative movement, which far surpassed the original one, the paper-carbon horseshoe lamp delineated in Fig. 7 of that article.

The magnitude attained in this speculative movement at the date of my *Times* interview, of Dec. 28, 1879, may be estimated from an article, which appeared in the New York *Sun*, on Dec. 30, 1879, in which it is
5430 stated that Edison Electric Light stock had advanced in ten days from $1,000 to $4,860 per share of $100 par value.

These facts were known to me, in substance, and were present to my mind when conversing with the *Times* reporter by whom the interview referred to was prepared. Turning now to that interview, I would draw attention to what, I suppose, is the portion having most direct bearing on the present case, and
5431 which appears in the following words:

> "'Can you tell me, Professor,' asked the "reporter, 'what are some of the chief diffi- "'culties in the way of the success of Mr. "'Edison's light?' 'Well,' Prof. Morton re- "plied, 'the first difficulty of all is the pro- "'duction of a lamp which shall be thoroughly "'reliable, and neither complicated nor ex- "'pensive. All attempts up to the present "'lamp in this direction are acknowledged to
> 5432 "'be failures, and, as I have pointed out, "'there does not seem to be any novelty "'such as would authorize us to hope for a "'better success in the present one.'"

In reading over this statement it seems to me that, bearing in mind the subject matter actually referred to this statement was not only correct at the time it was uttered, but is equally true to-day, and entirely con-

sistent with everything which I have said or written 5433
since.

In the first place the success of Mr. Edison's light, referred to at that time, is manifestly not the technical operativeness of his lamp which was freely admitted, but its success as a competitor which should displace coal gas as an ordinary illuminant. In the second place, the lamp referred to as lacking new properties which would authorize anticipations of its suc-
cess as a competitor to coal gas, or the ordinary gas 5434
burner, was the paper-carbon lamp described in the *Herald* article. That lamp, be it remembered, was made by carbonizing paper, without any subsequent treatment; and my conclusion about it, as implied in the passage above quoted, was that it was not sufficiently reliable to secure its success.

Aside from the conspicuous fact that this lamp never attained any commercial use or success, I would quote here what Mr. Edison himself says about it in his an-
swer to Q. 441 on p. 269, Defendant's Record, Vol. 1., 5435
in the McKeesport case:—

> "441 Q. What defects, if any, in paper, "caused you to discontinue its use for com- "mercial purposes?
>
> "A. It did not give sufficient life; and if "it was attempted to make filaments of high "economy, the life was very short. Another "difficulty was, that paper is so uneven. In "the manufacture of paper, the pulp runs
> "out on the wire cloth very unevenly. The 5436
> "fibres are not perfectly mixed, but some lie "more in one direction than in another, and "these vary. The paper was not always "pure. It was loaded with different things. "While the paper, after being calendered, "seemed to be of the same thickness—really, "before passing it through the calender

5437

"rolls, it was very uneven in thickness.
"Passing it through the rolls pressed down
"the higher parts, and seemed to produce
"some harm to the texture. Another trouble
"was the cutting of these blanks from paper.
"It was very difficult to cut them even.
"Another defect was the carbonization, as
"the resulting carbon would be useless, since
5438 "without the tarry matter which comes from
"the decomposition of the cellulose flowing
"in between the fibrous, and on carbonizing
"locking them together, the paper could not
"be used. But, fortunately, this tarry mat-
"ter flowed while exuding from the decom-
"posing cellulose between the fibres, and in
"carbonizing locked them together. It was
"enough to prevent cohesion between those
"kinds of carbons and the carbon of the
5439 "cellulose. Great care was necessary to be
"exercised in causing the heat during the
"act of carbonization to be conducted equally
"and simultaneously to all parts of the de-
"composing cellulose, so that no one part
"should be decomposed before the other, as
"great contraction took place, and this
"would make a very unhomogenous conduc-
"tor (carbon being internally under great
"strain in various directions, like unannealed
5440 "glass), and it also produces greater or less
"contraction in different parts of the resultant
"carbon, so that when put in a lamp and
"brought up to a red heat, some parts would
"be a dull red, and others would be a bright
"yellow, the filaments being destroyed at the
"hottest part. In fact, at the time that we
"used paper we found extreme difficulty in
"getting a great number of lamps free from

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"spots so that they could be used; but when
"we got bamboo our troubles practically
"disappeared, as all these difficulties, or
"nearly all, were absent when bamboo was
"used."

From this it appears to me that Mr. Edison is entirely in accord with me in the opinion expressed in 1879, and now repeated, that the paper-carbon lamp referred to in the *Herald* article did not possess the
quality of reliability which would have been necessary 5442
in order that it might compete with coal gas as a commercial illuminant. As a matter of fact, nevertheless, improvements have been made on the structure of analogous lamps by which their reliability has been greatly increased. Among these improvements are numerous ones covered by patents to Mr. Edison involving selection and preparation of the fibrous material, that is, bamboo, which he has selected as best fitted for this purpose and in the method of its carbonization, some of which
are so delicate and difficult that according to his own 5443
statement they do not admit of adequate description. Others have been made by other inventors, such as the various processes for hydro-carbon treatment, covered in the Maxim patents Nos. 261,741, 405,170, 405,239. With all these and other improvements, however, it does not appear that at the present day the electric lamp possesses such a superiority over the gas-burner as to substantially compete with it, still less as to generally displace it; and it is, therefore, very manifest,
that all I indicated on this subject as to the paper- 5444
carbon lamp of the *Herald* article was and is entirely correct.

The next point to which I made reference was the economy or lack of economy of these lamps in their cost of manufacture. It was claimed at that date that they cost but twenty-five cents apiece or even less in their manufacture. From what I knew of the cost of Geissler tubes which, as regards structure and

exhaustion were substantially identical with the proposed Edison lamp, I was fully convinced that the cost of manufacturing such lamps, including the loss by breakage both of carbons and of the enclosing glass bulbs, would be very much greater, and, in fact, I have reliable information that for some time after the manufacture of such lamps began to be carried on upon a considerable scale, their cost was from $1.25 to $1.50 apiece, and it is only by numberless new inventions
5446 and improvements made since 1879 that the cost of electric lamps to-day, when manufactured under the most favorable circumstances, has been reduced to somewhere about the figure originally stated. In this respect, also, I think that time or subsequent events have fully sustained what I stated in this interview, and that the same is also true in reference to the next difficulty referred to at that time, namely, the cost of distribution or, as it was otherwise referred to, the loss involved in subdivision. It is substantially
5447 true to-day as it was then, that, with the use of such lamps as were then known, including this paper-carbon lamp, the amount of light obtainable by incandescent lamps for a given expenditure of energy in a central station is only about one-tenth of that obtained with arc lights, and, as compared with gas, gives us about an equality if we consider only the fuel consumed and leave out of consideration all the advantages which gas possesses in the value of its residuals, the cheapness of labor employed, the economy resulting from
5448 the possibility of storage and the cheapness of the plant required. This subject I fully discussed in an article which appeared in the publication entitled *The Stevens Indicator*, Vol. VI., No. 3, July, 1889.

All these matters being considered, I think that there is nothing in this *Times* interview which is not entirely true even to-day, and bearing in mind that in that interview I was considering the Edison paper-

carbon lamp as a competitor to the ordinary gas burner, and was not considering or discussing, but had freely admitted, its technical operativeness, there is nothing in any way inconsistent or at conflict with anything I have said in my testimony in the present case or in the McKeesport case, or elsewhere.

Considering, in the next place, the report of my lecture in the *American Gaslight Journal*, I may say that the situation was the same as I have already described, and that the standard of efficiency was also the same; 5450
and this appears, as I think, very plainly from the following extract which expresses, as I think, the gist of the matter as expressed in that report. I quote as follows:

> "It is certain that none of these lamps "have yet demonstrated anything like such "practical success as can enable us to see that "they can take the place of gas in ordinary "illumination. They have, of course, many "advantages in certain respects over the 5451
> "electric arc, but these are combined with "compensating drawbacks on the part of "economy; and it is only by turning our "eyes to the as yet *unrevealed possibilities of* "*the future* that we are able to see the elec- "light as *a successful substitute for gas and* "*other methods of illumination.*"

And the same explanations apply with equal force to my letter in *The Sanitary Engineer* of December 22, 5452
1879.

84 Red Q. Mr. Edison, in his testimony in the McKeesport case, gives in his answer to Q. 485 on page 286 of the printed record, his views with regard to the necessary characteristics of a lamp suitable for the purpose he had in view as follows: "That the light should be produced sufficiently economically to commercially compete with gas. That the lamp should be durable,

5453 and capable of being handled by the public, and cheap to manufacture and one that would remain incandescent and stable a great length of time." Would the lamp described in the *Herald* article, in your opinion, comply with these requirements as stated by Mr. Edison?

A. It would not, and the reason why it would not I have fully developed in my previous answers, except that of being "capable of being handled by the public," which I have not before specially mentioned, but
5454 which was not a capacity possessed by this lamp, which as a matter of fact was very delicate and liable to be broken by mechanical shocks which appeared among other things from the experience had with some of these lamps on the steamer Columbia where they failed in great numbers from this cause.

85 R-d Q. It is now some ten or eleven years since you made the statements contained in the various articles referred to. How far is the incandescent system of electric lighting, with all the improvements that
5455 have been made in the meantime, capable in your opinion of competing with gas in cost, and how far has the incandescent electric light displaced gas so far as you know?

A. In a general way, for central-station distribution or in other words, for manufacturing at central works or stations and distribution to consumers over a large area, electricity cannot to-day at all compete with gas in economy, and it is only in what are known as isolated plants, and there under favorable conditions, that
5456 such competition is possible; and even in these cases it is doubtful whether a small gas plant located on the premises to be lighted might not be more economical than the small electric plant.

As to displacing gas, I should say that electricity had produced no appreciable effect. It has rather added to the means of illumination than displaced any of them. The growth in the manufacture and use of

gas during the last ten years has been more rapid than ever before, and this even in localities where the development in lighting by electricity has been most marked: and I have little doubt that to-day the number of gas burners in the United States is at least twenty times as great as the number of electric lamps and that twenty gas burners are put in for every electric lamp that is introduced day by day. 5457

86 R-d Q. In your answer to 79 and 80 R-d Qs you refer to the art of producing and maintaining perfect vacua as it stood prior to 1879 and afterwards. Please explain more fully what you mean by the statements contained in the answers referred to, in this regard? 5458

A. Long prior to 1879 it was well known how to produce and maintain vacua in such apparatus as Geissler tubes, but it was not until the Sawyer-Man process for removing occluded gases that a means was developed for maintaining such vacua under the conditions involved in the use of an incandescent electric lamp where the carbon conductor, its enlarged ends and the clamps and leading wires were all likely to give out occluded gas during the operation of the lamps. It is 5459
this provision in reference to the removal of the occluded gases that I had specially in mind in referring to the difficulties in producing and maintaining high vacua prior to 1879; and improvements in this direction have also been made since that date.

87 R-d Q. In your answer to 83 R-d Q. you refer to certain improvements in the process of hydro-carbon treatment introduced into the art since 1889. How essential in your opinion are these improvements or any of them for the purpose of making lamps of comparatively high resistance for use in multiple arc and 5460
how far would the process of hydro-carbon treatment as known prior to 1880 have been available for remedying the defects you have referred to as existing in the Edison paper-carbon lamp described in the *Herald* article?

5461 A. These improvements made since 1880 I regard as absolutely essential to the production of high resistance carbon lamps to be used in multiple arc when these are manufactured in the methods followed by those employing these treatments. The hydro-carbon treatment known before 1880—which I may call the liquid or atmospheric—pressure hydro-carbon treatment to distinguish it from the treatment in highly attenuated vapor of carbon, developed after 1880, would I
5462 think have been efficient in the manufacture of single lamps of relative low resistance, but would not have been available for high-resistance lamps or for the manufacture of lamps to be used in parallel or multiple arc, such for example as the lamp shown in the *Herald* article.

Adjourned for luncheon.

Defendant's Counsel offers in evidence the
5463 article published in the New York *Evening Post* of Nov. 12, 1878, referred to by the witness in his answer to 83 R-d Q., which is marked "Defendant's Exhibit *Evening Post* Article of Nov. 12, 1878;" also the article published in the New York *Sun* of Nov. 25, 1878, referred to in the same answer, which is marked "Defendant's Exhibit *Sun* Article of Nov 25, 1878;" also the letter from Dr. Barker, referred to in the same answer, which is marked "Defendant's Exhibit Barker-Morton
5464 Letter;" also the letter from Mr. Edison referred to in the same answer, which is marked "Defendant's Exhibit Edison-Morton Letter;" also the article published in the New York *Sun* of Dec. 30, 1879, referred to in the same answer, which is marked "Defendant's Exhibit *Sun* Article of Dec. 30, 1879;" and also Patent Office copies of the United States patents of Hiram S. Maxim, referred to

in the same answer, which are marked respectively "Defendant's Exhibit Maxim Patent No. 261,741, No. 405,170 and No. 405,239." 5465

Proof of publication of the various articles at the various dates referred to, is waived and Complainant's counsel consents that typewriter copies may be used in evidence instead of the original publications.

Re-cross examination of Dr. Morton by Mr. Dyer. 5466

88 R-x Q. What was the nature of your connection with the gas interests in the fall of 1878, if any?

A. No direct or positive connection. I had several acquaintances among the superintendents of gas works in New York and Brooklyn, and was also intimate with a Captain Dresser who was then editor of the *Gas Light Journal*; he frequently visited me, and at his request I wrote several articles for his journal on the subject of water-gas and other matters of which I had special 5467
knowledge from having made analysis for different persons who were in one way or another interested in knowing about the composition of various products used as illuminating gases. At the request, I think, of Captain Dresser, I had promises in 1887, long before there was any talk of Edison in connection with electric lights to deliver a lecture before the Society of Gas Engineers at their next meeting in New York, which happened to come just at the time of the first excitement in connection with the announcement of 5468
Edison's discovery.

89 R-x Q. Were you then, or did you subsequently become, a holder of gas stocks?

A. Neither, that is, I held no gas stocks at that time and have never held any since.

90 R-x Q. If your connection with gas interests was one only of friendship for individuals at the time referred to, did it afterwards become more than a mere

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friendly interest; that is, did you not receive employment in one form or another from gas interests subsequently?

A. Not to any extent nor in any way in connection with anything but my usual business as an expert in patent suits. In other words, from that time to this, I have been retained in two cases, one of them being for the patent controlled by the Company, and the other for the Lowe patents, controlled by the United Gas Improvement Co.; the first retainer I re-
5470 ceived about six years ago, and the last about three years ago.

91 R-x Q. I understand you to have said in substance that your lecture published in the *American Gas Light Journal* was a paper prepared upon the text of your lecture delivered October 17, 1878, before the American Gas Light Association, but with considerable additional matter; was the lecture itself reported in the New York papers?

A. It was in this sense, that reports prepared and
5471 written by newspaper reporters were published; but I did not prepare and furnish any such report myself for publication.

92 R-x Q. In your scrap book which you have kindly loaned me, I find a report of the lecture referred to in the New York *Tribune* for October, 1878. From that report I read as follows:

" ILLUSTRATIONS AND EXPERIMENTS.

5472 " Now among these productions I propose
" to name and illustrate a few, such as our
" time will admit. In the first place, lights of
" moderate intensity may be produced by
" heating a substance through which the elec-
" tric current passes. And this I will illus-
" trate by heating a platinum wire. (A glass-

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" jar through which a platinum wire had been
" run, was placed on the lecturer's desk, and
" the ends of the wire were connected with
" the poles of a battery. The platinum wire
" glowed with heat and emitted a mild yellow-
" ish light, equal in intensity to that of an
" ordinary lamp. Prof. Morton explained that
" the light was caused by the resistance in the
" wire, which produced heat, and that the wire
" would be consumed if heated beyond a cer- 5474
" tain point.) Hundreds of experiments have
" been made already on this subject, both in
" this country and abroad, and there are
" numerous patents and devices of lamps in
" which this is the ruling feature. In all of
" these there, is this feature of difficulty: as
" soon as the intensity of the light is dimin-
" ished by subdivision, the percentage of
" light enormously decreases, so that when a
" given electric force, being applied to one 5475
" lamp produces a light of, say 80 burners, di-
" vided into two lamps, it falls off into 30
" burners for the two, and so on. * * *
" The very rapid improvements which have
" been made in electric light, and the great
" extent of its use have caused, as everyone
" knows, no little excitement on the subject of
" its probable future. In evidence of that, I
" will read a letter which I received a few days
" since from one of our public institutions of 5476
" learning, not in this State but quite a prom-
" inent one, in which the following question
" is put to me, the writer stating that he has
" been informed that the electric light is in-
" troduced in the Stevens Institute. He says
" that the directors of his institute would be
" glad to learn how far its introduction had

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"met approval, and whether the existing "pipes, burners, etc., can be utilized. Now "any such idea as this is certainly far, if we "may call it, in advance of any existing foun-"dation. Granting every probable—I may "almost say every possible improvement in "these directions, we may very safely say that "no such radical change as is contemplated
5478 "in the mind of this writer need be expected "this century. The electric light has its "field, and it is a vast one. But that field is not "certainly in the near future, that of what we "may call private illumination of dwelling "houses and the like."

Is that report, in the portions read by me, a substantially accurate report?

A. It is a very fair report for the work of an ordinary newspaper reporter. In the first passage quoted
5479 the error is made of connecting what I said about arc and arc-incandescent lights with the experiment of the heated platinum wire so that it gives the impression that the loss from subdivision would be found in comparing incandescent lamps with each other, which would not be correct and was not the position stated by me at this lecture or at any other time. The latter part of the quotation is also defective in that it omits the direct reference and comparison with gas lights
5480 which was made at that time and to a considerable extent qualified the statements which in this quotation appear broader than they actually were. The actual position, as I stated it, being not that electricity would never be used for private illumination, but that it would never, or not for a long time, become the general substitute for gas in the lighting of private houses.

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93 R x Q. In stating that the first passage from the *Tribune* report is erroneous in that "it gives the impression that the loss from subdivision would be found, in comparing incandescent lamps with each other, which would not be correct," and which was not your position at that lecture or at any other time, did you have in mind the fact that in your *Gas Light Journal* article you do find the loss from subdivision in comparing incandescent lamps with each other, and that in that article you adopted the data given by Fontaine, 5482
on this subject without, however, mentioning the source of the data?

A. I had, but I think that you misunderstand the passage to which you refer in the *American Gas Light Journal*. In the *Gas Light Journal* I say "the second characteristic of these incandescent lamps is that with the same current, they develop much less light than is obtained from the electric arc. Thus a battery of 48 elements, with a Serrin lamp, gave an electric arc equal to 100 burners, but with one of these lamps gave a light 5483
equal only to 80 burners, and when divided between three lamps gave only a light of 10 burners each." I then say "the third characteristic is the manner in which the light-producing power of the current diminishes as it is distributed between a number of lamps," and I then give the data obtained, as you correctly state, from Fontaine.

Now, I do not of course mean to deny that there is a loss of efficiency between one incandescent lamp and another under certain conditions, but what I do 5484
mean is that the great loss in efficiency to which I was drawing attention in that lecture was that which occurred from the arc light to the incandescent light, and that while the reporter is correct in the individual parts of his statement, the impression he produces is incorrect because he has omitted a reference to what I said on that part of the subject.

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94 R-x Q. Were not the gas manufacturers pleased with the apparent success with which you had championed their cause?

A. I should rather say that the not unnatural alarm which had been excited among many of them by the very strong and reiterated assertions which appeared in the daily papers and elsewhere was much relieved by the impartial presentation of the actual facts of the situation which I had endeavored to give them;
5486 and I might add that I had the strange good fortune at the same time to give pleasure to some of those interested in the manufacture of dynamo machines and electric lights who were also present.

95 R-x Q. I read from an article published in the New York *Sun* for Oct. 19, 1878, which I find in your scrap-book:

> "The gas manufacturers were tardy in re-
> "convening yesterday. Long after the hour
> "for opening the morning session they stood
> 5487 "about in groups discussing Prof. Morton's
> "entertainment of the preceding evening.
> "There was manifest a tendency toward mer-
> "riment over the absurdity of anybody any
> "longer supposing it possible that the elec-
> "tric light should ever supersede gas. They
> "joked over it as something of which they
> "were not afraid. * * * After the meet-
> "ing was called to order the first business was
> "a vote of 'Thanks to Prof. Henry Morton
> 5488 "'(applause) for his very entertaining and in-
> "'structive lecture' (applause). Then the
> "Executive Committee reported certain re-
> "commendations which were acted upon as
> "follows:
>
> "'That Prof. Henry Morton (applause) be
> "'elected an honorary member of this asso-

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> "'ciation.' Adopted by the Secretary casting
> "one ballot.
>
> "'That the next annual meeting of the As-
> "'sociation be held in Philadelphia' adop-
> "ted.
>
> "'That Prof. Henry Morton's (applause)
> "'lecture, as he himself prepares it be print-
> "'ed as a part of the proceedings of this as-
> "'sociation.' Adopted.
>
> "The roll of members active and honorary 5490
> "was called and an omission having been in-
> "advertently made by the Secretary, he was
> "requested to correct it by calling the name
> "of Prof. Henry Morton (applause) which he
> "did."

Does this account correctly represent one phase of the matter, and was your lecture as you yourself prepared it printed as a part of the proceedings of that association?
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A. As I was not present at the meeting I am unable to testify as to the accuracy of the report from which you have quoted beyond the facts that I received a notice of my election as an honorary member, and that my lecture as I prepared it was published in the proceedings of the American Gas Light Association Vol. III.

96 R-x Q. As printed in the proceedings the lecture is in substance a copy of the *Gas Light Journal* publication, am I right? 5492

A. You are.

By Mr. Curtis:

97 R-x Q. You have stated on your re-cross examination that since the publication of the articles referred to you have been employed to a certain extent by manufacturers of gas; have you also since that

5493 time been employed by manufacturers of electric light apparatus, and if so to what extent as compared to your employment by gas manufacturers?

A. I have been employed by manufacturers of electric light apparatus in connection with various patent suits since the publication of these articles, and among the companies so employing me has been the Edison Company. The extent of this employment has been between 50 and 100 times that of my employment by
5494 the gas companies.

Re-cross by Mr. Dyer.

98 R-x Q. By what electric companies have you been principally employed, and in what capacity? Please state at the same time the extent of your employment by the Edison Company, when so employed, and in what capacity?

A. I have been employed by the Brush Company, the U. S. Electric Lighting Co., The U. S. Electric Il-
5495 luminating Co., The Thomson-Houston Co., The Gramme Electric Co., (a combination of various other companies including the Edison) the Electrical Accumulator Company and the Edison Co. In all cases I have been employed as an expert in reference to certain patents or patent suits, except in the case of the U. S. Illuminating Co. where I was employed in connection with suits in New York City in reference to the running of overhead wires. I only now recollect one case in which I was retained and gave testimony for the Edison Co. which was in a suit against the U. S. Elec-
5496 tric Co. on certain patents for armatures of dynamo machines, an interference in the Patent Office, although I recollect that I was asked to act in another case on a patent for an electric meter, but in looking into the state of the art I did not think I could give testimony which would be useful to the company, and therefore declined to receive a retainer.

Henry Morton.

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New York, January 21st, 1890.

Before Samuel W. Hitchcock, Examiner.

Present.—R. N. Dyer and Clarence A. Seward, for Plaintiff.

Samuel A. Duncan and Leonard E. Curtis for Defendant.

Oliver B. Shallenberger called for the defendant, and after being duly sworn says, in answer to interrogatories propounded by S. A. Duncan, Esq. 5498

1 Q. What is your name, age, residence and occupation?

A. Oliver B. Shallenberger; thirty; Rochester, Pennsylvania; Electrician.

2 Q. What acquaintance have you with the laws of electricity and with the practical application of those laws in the art of incandescent electric lighting?

A. I have been engaged in the study of electricity since 1880, and since 1884 have been directly associated with the Union Switch and Signal Company, and the 5499
Westinghouse Electric Company at Pittsburgh, in the electric lighting department. I made experiments during the winter of 1880 and 1881 on the Maxim form of incandescent lamp, and gained some experience in the carbonization and use of paper for such work. I have been chief electrician of the Westinghouse Electric Company since its organization, and since that time have devoted a large amount of time to the study of incandescent lamps and their production on a commer- 5500
cial scale. I was associated with Mr. Alexander de Lodyguine, of St. Petersburg, for about a year in carrying on an extensive series of experiments for the purpose of perfecting the lamps manufactured by the company as far as possible. I have made a number of experiments on incandescent lamps of various types including their manufacture, and particularly Sawyer-Man lamps of the type described in their early pat-

5501 ents. My connection with the company has also involved careful inquiry into methods of distribution of electrical energy with relation to their commercial requirements. During my connection with these companies, large numbers of incandescent lamps have been made for sale, amounting to several thousand daily, and for some months the Westinghouse Electric Company has been producing ten thousand or more carbons daily for the use of the Sawyer-Man Company, of New York.

3 Q. How does the electrical resistance of the
5502 carbon burner of an incandescent lamp when measured cold compare with the resistance of the same burner measured hot?

A. The resistance measured cold is approximately double the resistance when measured hot.

4 Q. Are you familiar with what is known in the art of incandescent lighting as the "hydro-carbon treatment," in the preparation of carbons to serve as the burners of the lamps?

A. I am, and have become acquainted with it
5503 through its use in preparing all the carbons made for incandescent lamps by the Westinghouse Company.

5 Q. Explain briefly what this "hydro-carbon treatment" is.

A. The carbon to be treated is clamped to suitable connections to a source of current, and after being covered with a glass bell-jar in such a way as to form an air tight chamber, the air is exhausted and the space is then filled with an attenuated atmosphere of hydro-carbon vapor; a current is then passed through the
5504 carbon sufficient to heat it to incandescence, producing a decomposition of the hydro-carbon gas and an absorption of the carbon so freed within the pores of the carbon conductor, as well as a deposit of carbon upon its surface. This process results in the consolidation of the structure of the carbon conductor by the filling of its pores, which results in a very marked reduction

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of its specific resistance, and this, together with the layer of deposited carbon on the surface, greatly reduces the total resistance of the conductor.

The process may be continued to such a degree as to produce a carbon of comparatively large cross-section from a very small original carbon, but this degree of treatment is rarely employed in practice. A carbon, as it is taken from the carbonizing furnace, may be reduced to one-fourth or one-fifth of its original resistance without greatly increasing the sectional
area; the specific resistance of the carbon considered 5506
as a whole may thus be reduced to one-third or one-fourth of the original specific resistance.

6 Q. In ordinary practice, what is the reduction in the specific resistance of the carbon effected by this "hydro-carbon treatment?"

A. It varies somewhat, but the usual reduction is such as to produce a carbon of from one-fourth to two-thirds the specific resistance of the original carbon.

7 Q. How generally has this "hydro-carbon treatment" been practiced in the manufacture of carbons 5507
for incandescent lamps?

A. It is practiced, I believe, by nearly all of the makers of incandescent lamps both in this country and in England. As for instance, The Sawyer-Man Company, The Thomson-Houston Company, The United States Company, The Heisler Company, and others in this country, and, so far as I know, all the companies in Europe.

8. Q. State whether, in accordance with request of
counsel for defendant, you have prepared various series 5508
of illustrative incandescent lamps; and, if so, please produce the lamps so made, and explain their construction?

A. I have prepared such lamps, in connection with my assistant, Mr. F. S. Smith, and produce the same herewith.

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These lamps have been made by the usual method of manufacture of the Westinghouse Electric Co.; the burners being made of silk thread, carbonized by the usual process, then subjected to the hydro-carbon treatment, joined to the platinum wires in the usual mode, and finally sealed up in the exhausted glass globes.

The lengths, diameters and resistances of the burners of these lamps, the current required to bring them
5510 to incandescence, their illuminating power and the diameters of the platinum leading-in wires, are given in tabulated statements which I have prepared and submit herewith, as follows:

SERIES I, consists of six lamps, in which the burners have each an effective length of about one inch; their diameters varying from .004 of an inch to .054 of an inch; the resistances from .52 to 105 ohms; and the candle power from 2 to 21 candles. These are more fully given in the following table:
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Series I. Length 1". (About.)

Lamps No.	Diameter of Burner.	Diameter of Leading-in Wire.	Current at Incandescence.	Candle Power.	Resistance. Cold.	Resistance. Hot.
596. 1	.004	.016	0.37	2.0	105. a.	52.5a.
595. a.	.014	.025	3.53	6.0	3.39	1.69
594. a.	.024	.028	9.55	6.2	.94	.47
597. b.	.034	.050	11.8	10.0	.87	.435
598. 2	.044	.050	19.0	12.5	.42	.21
599. 2	.054	.080	21.0	21.0	.52	.26

SERIES II consists of six lamps answering in all sub-
5512 stantial respects to the six lamps of Series I, except that the carbons, instead of being straight, as in that series, are arched.

SERIES III, consists of seven lamps, in which the burners have a length of about seven and one-fourth inches each, but with different diameters, varying from .003 to .054 of an inch, and with a variation in resistance from 2.2 to 2060 ohms, and in candle power from 5 to 75 candles, as per the following table:

5513

Series III. Length 7.25". (About.)

Lamps No.	Diameter of Burner.	Diameter of Leading-in Wire.	Current at Incandescence.	Candle Power	Resistance Cold	Resistance Hot
565x 2	.003	.014	(2) 0.142	5.	2060.00	1140.0
565. a.	.005	.014	0.37	16.	740.00	352.0
584. 1	.014	.025	3.18	32.	23.00	11.6
585. 1	.024	.033	9.0	53.	5.51	2.60
586. 1	.034	.047	11.5	75.	1.68	2.34
587. 2	.044	.050	17.8	54.	2.21	1.18
570. c.	.054	.080	20.8	60.	2.20	

SERIES IV consists of six lamps in which the carbons 5514
vary both in length and diameter, each lamp being designed to give 16 candles light. The diameters of the carbons range from .004 to .056 inches; the length from 1.37 to 7¼ inches; and the resistances from .42 to 740 ohms, as per the following table:

Series IV. All Measured for 16 Candles.

Lamps No	Diameter of Burner.	Diameter of Leading-in Wire	Current used to secure Incand.	Length.	Resistance Cold	Resistance Hot
565. b.	.004	.014	37.	7.25	740.00	370.0
590.	.012	.022	2.74	5.375	19.30	9.7 5515
591. a.	.025	.030	8.	4.25	3.64	1.82
592. a.	.035	.050	12.	3.06	1.86	.93
593. a.	.043	.050	15.	2.125	1.14	.57
593x 3	.056	.080	20.8	1.375	.42	.21

SERIES V consists of seven lamps in which the carbons are of the same diameter but vary in length; the lengths ranging from 1.25 to 7.25 inches, the resistances from 15 to 88 ohms, and the candle-power from 3.8 to 16 candles, as per table herewith:

Series V. Measured at 1.25. 5516

Lamps No.	Diameter of Burner	Diameter of Leading-in Wire	Length.	Candles.	Resistance Cold	Resistance Hot
583. a.	.008	.018 (2)	7.25	16.0	88.	44.0
" b.	"	"	6.25	13.5	75.	37.5
" c.	"	"	5.25	11.5	63.	31.5
" d.	"	"	4.25	8.7	50.	25.0
" e.	"	"	3.25	7.0	38.	19.0
" f.	"	"	2.25	5.0	26.	13.0
" g.	"	"	1.25	3.78	15.	7.5

5517

From lack of time we have not as yet made any extensive life-tests of these lamps, although some of them (or rather duplicates of them) have been run some 60 or 70 hours; but all of them have been tested on the pumps for three or four hours, and with a current much higher than would be used in practice. I deem them all good serviceable lamps, and have no doubt as to their reasonable durability.

5518 Defendant's counsel offers the said lamps in evidence, and the same are marked respectively as "Defendant's Exhibits, Shallenberger Lamps Series I, Series II, Series III, Series IV, Series V."

9 Q. Have you separate specimens of the carbons of these lamps?

A. I have and produce the same herewith, and will mount them on cards for their better protection.

5519 Defendant's counsel offers said carbons in evidence, and the same are marked respectively "Defendant's Exhibits Shallenberger Carbons Series I, Series II, Series III, Series IV, Series V."

10 Q. What are the materials of late years most generally used in the manufacture of the carbon burners of incandescent lamps?

A. Bamboo, silk thread, cotton thread, paper, tamidine. These cover the principal ones in use.

5520 11 Q. How well adapted would these various materials be for burners for incandescent lamps if the strips or pieces to be used were to be carbonized, and then, without being subjected to the hydro-carbon or some other treatment subsequent to the carbonization were to be introduced into the globe of the lamp and sealed up?

5521

A. Carbons mounted without any treatment subsequent to simple carbonization would not be suitable for use in incandescent lamps, for the reason that they contain gases which must be driven off before the lamp is sealed up. The carbon is also in a condition after baking which requires some further consolidation of its structure, such as may be produced by the passage of a current of electricity through it sufficient to bring it to a high incandescence. This operation drives out the gases at the same time, and 5522 they are carried out of the lamp-bulb by the pumps, before the exhaustion can be considered complete. Without this process, a lamp begins to deposit carbon on the interior of the glass immediately after it is put in use, and soon deteriorates to a degree that renders it practically useless.

12 Q. Do you know of any system of incandescent lamps in commercial use, in which the carbon burners have not been subjected to some special treatment after carbonization and before being sealed up in the 5523 exhausted globe?

A. No, I do not.

13 Q. The "hydro-carbon treatment," as I have understood your explanation, is a treatment to which the material composing the burner of the lamp, is subjected after the process usually known as carbonization. Is this correct?

A. Yes, the process is applied to carbons as they leave the carbonizing furnace.

14 Q. In making carbons for incandescent lamps, 5524 what is the effect of the carbonization upon the flexibility of the material out of which the burners are made?

A. The effect is to very greatly reduce the flexibility and to such an extent that great care is necessary in handling such carbons to prevent their rupture before they are mounted to be placed in the bulb.

5525
15 Q. What effect does it have on the specific re-
sistance of a carbon burner that the material com-
posing it is reduced to form before carbonization, as
compared to carbonizing the material first and then re-
ducing it to the required form?

A. It has absolutely no effect on the specific re-
sistance.

16 Q. What is the relative advantage of small and
large cross-section of the carbon burner of an incan-
descent lamp as regards ability to secure and main-
5526 tain effective contact between the burner and the con-
ducting wires?

A. For a considerable range in cross-section, say
from a diameter of four or five thousandths of an inch
up to sixty or eighty thousandths (one and one-half to
two millimeters), there is no particular difficulty or
difference dependent on the size of the carbon. I have
produced lamps having carbons throughout this range
of cross-section, without difficulty, by using the ordin-
ary methods of attachment as employed in making
5527 commercial lamps. Carbons of smaller diameters than
those mentioned are more difficult to handle and re-
quire greater care in mounting. Larger sizes could, in
my opinion, be successfully attached by the same
methods, but I have never had occasion to make the
attempt. The carbons most easily joined to the lead-
ing wires, are those large enough to be handled con-
veniently and not so large as to require an excessively
large deposit of cement to make a good joint. By
properly regulating the process it is almost a matter
5528 of indifference as to the size of the carbon.

17 Q. Please refer to the paper now handed you
marked "Complainant's List of Edison Lamps," and
state how many, and which, of the different types of
lamps named and described in said list, are adapted for
use in multiple arc with any system of electrical dis-
tribution known to the art in the year 1880?

5429
A. The types of lamps described in the list referred
to may be classified under three general heads.

First: The lamps ranging from one hundred and
twelve down to ninety-three volts, classified as "one
hundred candle power," "fifty candle power," "thirty-
two candle power," "twenty-four candle power," "twen-
ty candle power," "sixteen candle power new lamps,"
and "sixteen candle power old lamps," and "ten can-
dle power new lamps;" this series of lamps is adapted
for multiple-arc distribution by such methods as were 5430
known at the time specified, over limited areas and in
considerable numbers, provided the conditions were
such as to require the installation of a large number
of lamps near the source of current. These lamps
which are of the highest resistance relatively to the
amount of light given contained in the list, are not of
sufficiently high resistance to render commercially suc-
cessful an installation depending on simple multiple-
arc distribution without the aid of regulating methods
and apparatus introduced into the art since 1880, un- 5431
less such installation is limited as to the area lighted
as I have before indicated. By the use of a number
of improvements in the art of electrical distribution, it
has become possible to increase the electrical pressures
without increasing the resistance of the lamps, and,
at the same time, to use conductors of smaller size and
therefore greater resistance, without interfering with
the successful operation of the lamps. We find that by
the use of such appliances, central-station lighting,
broadly considered, has become possible, and not until 5432
these newer methods and appliances were introduced.

Second: The lamps classified as "sixteen can-
dle-power, seventy-volt, new lamps," "sixteen
candle power, B new lamps," and "sixteen
candle power, B old lamps," which range in
cold resistance from one hundred and forty-

5533 seven ohms down to sixty-three ohms (the resistance hot being of course about one-half these figures), and which are adapted for use on circuits supplied at a pressure of from seventy-one volts to fifty-four volts, constitute another class of much more limited usefulness. Such lamps could only be used in a profitable way when massed near the source of current, if supplied directly in multiple arc; in this way they would be useful for the lighting of a large building or group of buildings located very near each other, but would
5534 cease to be profitable for any extension of circuits to a distance of more than a few hundred feet. This results from the fact that the cost of conductors increases as the square of the distance and inversely as the square of the electrical pressure.

Third: The remaining lamps are entirely unsuited for distribution in multiple arc on any practical scale as their resistances are so low, as well as the pressure
5535 for which they are intended, that the circuits designed to supply them with current would be uselessly expensive and cumbersome to install; the resistances of these lamps vary from nineteen to one and two-thirds ohms cold, (resistances hot one-half of these amounts.)

Adjourned to Wednesday, January 22nd, at 11 A. M.

New York City, January 22, 11 A. M.

5536 Met pursuant to adjournment.

Present: counsel as before.

Witness resumes his answer, as follows:

The lamps comprised in this last class are those which in the List of Edison Lamps are designated as "30-candle power Municipal New Lamps;" "15-candle

power Municipal New Lamps;" "20-candle power Municipal New Lamps;" "25-candle power Municipal New Lamps;" 5537

"½-candle power small lamps;"
"3-candle power small lamps;"
"1-candle power small lamps;"
"4-candle power small lamps;"
"2-candle power small lamps;"
"6-candle power small lamps;"
"Surgical ½-candle power;"
"½-candle power pea lamp;" 5538
"½-candle power dental lamp;"
"20-candle power Municipal Old Lamps;"
"16-candle power, 3½ amperes, old lamp, Municipal."

18 Q. Please state whether any of the different types of these Edison lamps are especially adapted for lighting "*in series*"?

A. All of the lamps classified as "Municipal" lamps are suitable for connection in series; and the remaining small lamps could be used in series to advantage in special cases, but not in multiple arc for any extended 5539 distribution.

19 Q. In your last answer but one, you have spoken of "central-station" lighting. What does that term signify in connection with the art of incandescent lighting?

A. Central-station lighting means the distribution of current from some point at which the generators are situated, under such conditions as to render it possible to supply electric lights, comparable in the amount of light given by ordinary gas jets and over areas suffici- 5540 ent to furnish electric lamps in the same way as gas is distributed for the lighting of residences, stores and other buildings, as the demand may require.

20 Q. State whether, with the mode of distributing the electric current known in 1880, it would have been practicable to use for central-station lighting an incan-

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descent lamp having a resistance of less than 100 ohms hot?

A. No; it would not have been practicable, because the pressure at which such a lamp would be operated would be such as to render it practically impossible to supply current to it by such means as were known for central-station purposes. The cost of distribution would have been so great as to render such distribution prohibitive in cost of conductors.

5542 21 Q. State whether defendant's M. lamp (which has a resistance cold of 78.9 ohms and hot of about 40 ohms, and which is designed for use on a 60 volt circuit and to give a light of 16 candles) could to-day be used practically for central-station lighting without supplying the current to it by some system of electrical distribution not practiced or known to the art in the year 1880?

A. Such a lamp could not be so used, and for the reasons stated in the last answer. The difficulties
5543 would be enormously greater with this lamp than with one approximating 100 ohms.

22 Q. Same question in reference to defendant's Zig-Zag paper lamp, the resistance of which is 158.2 ohms cold (about 80 ohms hot), and which is designed for use on a 70 volt circuit, giving a light of 16 candles.

A. This lamp is also of a resistance too low for central-station distribution.

23 Q. How small a carbon have you ever made which you have found to work successfully in an in-
5544 candescent lamp?

A. I have used a carbon as small as .003 of an inch in diameter with perfect success, and this carbon was made of the smallest silk obtainable. A smaller size could undoubtedly be made. Given the proper material for carbonization and of sufficiently small cross-section, a carbon .003 of an inch in diameter can be made and mounted in a lamp by the same methods or-

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dinarily employed for larger carbons, the difference being in degree simply. Such a lamp having a carbon as described, has been put in evidence as the first of series III, and the resistance, candle-power and other data are there recorded.

24 Q. What is the usual size of the platinum leading-in wires of commercial incandescent lamps?

A. For such lamps as are ordinarily used the size of the platinum ranges from .012 to .016 of an inch in diameter.

25 Q. How large platinum leading-in wires can be 5546
effectively sealed into the globe of an incandescent lamp by fusing the glass directly to the wire and have the seal reliable and efficient?

A. I have found no difficulty in sealing wires of a diameter of .080 of an inch, which corresponds very nearly to a diameter of two millimetres. From the results of this work I have no doubt that still larger wires could be sealed without serious difficulty. The largest wires used in some of the lamps offered in evidence are of this diameter and have given excellent 5547
results, showing that practical commercial lamps could be so made whenever required.

26 Q. Is the method of sealing the glass directly on to one of these large wires the same as that used in making the corresponding seal of the ordinary commercial lamp?

A. Yes. The method used was the same in all respects.

27 Q. How heavy a current can you pass over these large (.080 of an inch) platinum leading-in wires with- 5548
out endangering the seal?

A. I have passed currents of 35 amperes through such wires without developing any evidence of leakage of air into the bulb, and in some cases a current of this amount was sufficient to heat the platinum wires to redness down to their point of juncture with the glass, and without cracking or otherwise injuring the seal.

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Such a current is rather in excess of what would be ordinarily carried on a wire of this diameter, but from 25 to 30 amperes could be used with success.

28 Q. How large sized carbons have you ever used in incandescent lamps with platinum leading-in wires .080 of an inch in diameter?

A. I have used carbons up to a diameter of .055 to .060 of an inch with such leading-in wires. Lamps made with carbons of this diameter have been put in
5550 evidence in Series I, II and IV.

29 Q. How do these large-sized carbons, found in the lamps in Series I, II and IV, compare in the matter of rigidity with Carré carbons? I assume that you are familiar with the latter carbons.

A. I am familiar with Carré carbons, and have used them in making incandescent lamps. The rigidity of these carbons of large diameter used in the Series of lamps offered in evidence, is perhaps slightly less than that of Carré carbons, but the difference is not such as
5551 to be very marked, owing to the large diameters. By less rigid I mean, that if equal lengths of the two kinds of carbons were supported firmly at one end, the Carré carbon would be a little stiffer when an attempt is made to displace the free end from its normal position.

30 Q. Are you familiar with the Bernstein lamp, the Thomson-Horston Series lamp, the Schuyler and the Heissler lamps; all of which, I believe, are commercial lamps now in the market?

5552 A. Yes, I am familiar with these lamps.

31 Q. Could any of these lamps be used advantageously in multiple arc?

A. No. Such lamps would not be at all adapted for multiple-arc distribution. These lamps are intended to be run in series, usually upon circuits supplying arc lights also in series, and are of sufficiently low resistance to make them suitable for currents of about 9 or 10 amperes or more. The cross-section of these car-

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bons is therefore comparatively large and the length short. The pressure required to supply them with current in multiple arc would, therefore, be very low, and much too low for any electrical distribution.

32 Q. If, in the year 1878, lamps like the Bernstein lamp or any of the Edison Municipal lamps had been shown and explained to a person familiar with the laws of electricity, and such person had been requested to construct, or direct the construction of, other lamps of the same general character, but which should be 5554
adapted for use in multiple arc, the candle-power of the lamp remaining unchanged, would such person have known the nature of the changes in the size and proportions of the carbon that would be necessary to effect the desired results.

Objected to by counsel for complainant as irrelevant and immaterial.

A. Long prior to this date, the laws governing the distribution of electrical energy in circuits were well 5555
understood, and I see no reason to doubt that any one familiar with these laws would have easily arrived at the conclusion that a carbon conductor of low resistance was unsuited to extended distribution in multiple arc; and, since the fact was well-known that any two conductors of the same specific resistance were of relative total resistances directly proportional to their lengths and inversely as the cross-sections, it seems evident to me that the line of modification required would have been indicated at once by a knowledge of 5556
this principle. I was myself at this time familiar with calculations relating to distribution of currents both in multiple-arc and series circuits. As a student of engineering at the United States Naval Academy I was frequently required to solve problems of this exact nature for the purpose of determining the proper proportions for torpedo fuses and their leading wires and

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the battery pressure required for their proper opera-
tion. These problems included arrangements in mul-
tiple arc and in series, and general investigation
of the proper relation of resistances in the devices
to be operated, the leading wires and the bat-
teries or dynamo. I was familiar at this time
with the fact that where it was desired to
obtain a heating effect from the current, as in
the case of a torpedo fuse, that it was necessary to have
the combined resistance of all the fuses in circuit high
5558 enough to be suited to the resistance of the leading
wires. I was also familiar with the fact that if a num-
ber of conductors to be heated were arranged in mul-
tiple arc, the combined resistance would be made lower
by so joining them, unless at the same time the resist-
ance of each of the conductors so joined together was
made great proportionally to the number connected to-
gether.

It therefore appears to my mind that the method of
operating lamps in multiple arc would have been so
5559 well understood at this time as to render it a matter
of easy calculation to determine what would be the
proper change to make in suiting lamps having low-re-
sistance conductors for use in multiple arc. By giving
such lamp a comparatively high resistance, either by
lengthening the conductor or making it of smaller
cross-section, the combined resistance of a number of
such lamps connected in multiple arc would be higher,
and consequently the resistance of the work-circuit
would be higher in proportion to the leading wires, than
5560 by using the carbons of low resistance. This result
would have been at once considered desirable, and
would have been immediately suggested to the mind of
anyone familiar with the laws governing the distribu-
tion of currents at the time specified.

33 Q. I now hand you a lamp marked "Defend-
ant's Exhibit Lamp with Sawyer-Man Carré carbon"

and ask you to explain in regard to the making of the 5561
same?

A. This lamp contains a piece of carbon sent to me
by L. E. Curtis with the statement that it had been
furnished to him by Mr. Man, and with a request that
I should make measurements of its dimensions and of
the current required to bring it to incandescence. I
found the diameter to be forty-two thousandths of an
inch (about one millimeter) the length one and five-
tenths inches, the resistance one and sixty-three hun- 5562
dredths ohms. It was mounted on platinum leading-
in wires, and the joint between the carbon and the
platinum cemented in the usual way and when so
mounted, sealed into the globe and exhausted as usual.
During the process of exhaustion it was heated to a
high temperature by the passage of a current. After
the lamp was completed the candle-power was measured
by the photometer at the usual incandescence and it
was found to require a current of ten and four-tenths
amperes and to give a light of thirteen candle power. 5563
The lamp gave every indication of being a thoroughly
practical lamp. The diameter of the leading wires in
this lamp is about one and one-half millimeters.

34 Q. How does the diameter of the carbon in said
lamp compare with that of "Defendant's Exhibit Car-
bons produced by Albon Man L. V., No. 1, January 4,
1890, S. M. H. Exr"?

A. The two diameters are very nearly the same, that
is, about one millimeter.

35 Q. How is it with the quality of the carbons of 5564
the two Exhibits?

A. They appear to be exactly the same quality of
carbon.

36 Q. You were a witness in the suit of the Consol-
idated Electric Light Company against the McKees-
port Electric Light Company lately decided in the
Western District of Pennsylvania?

A. I was.

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37 Q. In that case I believe you made six incandescent lamps which contained carbons illustrating the invention described in the Sawyer and Man patent Number 317,676 and which also illustrated the mode of uniting the globe and base of the lamp, as well as the mode of introducing the leading-in wires shown in the earlier Sawyer and Man patents No. 205,144, of June 8, 1878, and No. 210,809, of December 10, 1878, which lamps were made Exhibits in that suit?

5566 A. Yes.

38 Q. What was the construction of those six lamps and how did they operate?

A. For the answer to this question I will adopt my answer to question 4 in the McKeesport case. The patent in suit in that case being the Sawyer & Man patent No. 317,676, dated May 12, 1885, the references to "the patent" and "the patent in suit" are to this patent No. 317,676. My answer taken from that case so far as it relates to the six lamps referred to, is as
5567 follows:

"I here produce six lamps, five of which are
"mechanically constructed in exact accordance
"with the drawings and description in the patent.
"The five lamps are marked 'Complainant's Ex-
"hibit Pittsburgh Sawyer-Man Lamp No. 1, Paper
"Carbon,' together with the exhibits Nos. 2, 3, 4
"and 5 and are constructed mechanically as near-
"ly like the patent in suit as possible. The car-
"bon is supported by two carbon clamps, except
5568 "in lamp No. 2, in which the clamps are of plat-
"inum; these clamps are supported on a disc as
"shown in the drawings, and insulated from each
"other; the supports for the clamp extend
"through the disc, and are electrically connected
"to copper conductors of corrugated form, which
"extend to the base of the lamp. The latter con-
"sists of a plate of glass having two openings

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"about a quarter of an inch in diameter through
"which tubular bolts pass. These bolts are con-
"structed as shown in figure 5, of the patent in
"suit, which is as follows: A tube about three-
"eighths of an inch in diameter is turned off at one
"end to a diameter sufficient to allow it to pass
"through the holes in the plate leaving a flat
"flange to bear against the lower surfaces of the
"plate, the smaller end of the tube which pro-
"jects inside of the lamp is threaded for attach- 5570
"ment to the ends of the corrugated conductor.
"The thicker end which projects outside of the
"lamp is provided with an air-tight valve by
"means of which the opening in the tube may be
"closed. A cap is provided to screw over the pro-
"jecting end of the tube when the lamp is finish-
"ed. The glass plate is ground to fit accurately
"against the flanges of the tube bolts, so that
"without cement of any kind the joint is pract-
"ically air-tight. These tube bolts serve the 5571
"double purpose of ducts through which the air
"may be exhausted, or nitrogen admitted, and of
"conductors for supplying current to the car-
"bon. Surrounding the carbon and conductors
"leading to it, and reaching down to the
"base plate is a tubular glass bulb provided with
"a flange at its lower extremity of the same ex-
"external diameter as the base plate; this flange
"is ground perfectly flat, as is also the surface of
"the base plate, so that when the two are placed 5572
"together they will form a practically air tight
"joint in the same way as the tube bolts. Two
"brass flanges are placed above and below the
"joint between the base plate and the flange of
"the bulb, and these are drawn together by iron
"screws, the pressure being softened by paper
"washers placed between the metal and the glass.
"The joints are made air-tight and permanent by a

5573 "thin coating of fir balsam applied previously to
"the assembling of the parts, and the base is pro-
"tected by a brass cap of substantially the form
"shown in the drawing. The lamp marked 'Com-
"complainant's Exhibit, Pittsburgh Sawyer-Man
"Lamp No. 6,' is constructed in substantial ac-
"cord with the specification of the patent in suit,
"but is modified in the details of the base; in-
"stead of the base plate, as shown in the draw-
5574 "ing, a bottle stopper is used which is ground to
"fit accurately on the internal surface of the
"mouth of the globe. Through this stopper two
"holes pass for the admission of the tube bolts.
"The latter are of the same construction as pre-
"viously described, except that instead of being
"formed of one piece they are composed of a
"platinum tube to which the thicker flanged por-
"tion is attached, the object of employing the
"platinum is to obtain nearly the same expansion
5575 "in the tube as in the stopper, and so maintain a
"tight joint. The clamps in which the carbon
"conductor is held in this lamp are of platinum;
"in other respects than those mentioned, it is
"constructed like the drawing figure 5, of the patent
"in suit. Each of these lamps was submitted to a
"test and the following records show briefly the re-
"sult.

"Lamp No. 1. Carbonized paper cut into
"arched form after carbonizing, tempered by heat-
5576 "ing in very attenuated hyro-carbon gas, bulb
"contains an atmosphere of nitrogen tested for one
"hundred and thirty-two hours and fifty minutes
"at a proper incandescence, and is still in good
"condition as may be judged by the appearance
"of the carbon and absence of blackening in the
"interior of the globe.

"Lamp No. 2. Paper carbon with platinum
"clamp. Globe exhausted to highest attainable

"vacuum. Tested for one hundred and thirty-one 5577
"hours and twenty minutes. Carbon now in good
"condition, no blackening of the bulb, vacuum at
"the end of test good.

"Lamp No. 3. Willow carbon. Atmosphere of
"nitrogen. Run at about sixteen candles for one
"hundred and fifty-six hours and three minutes.
"Is now in as perfect condition apparently as
"when started; no blackening of bulb. Carbon
"perfectly bright and clean.

"Lamp No. 4. Silk-carbon, vacuum lamp. Ran 5578
"for two hundred hours. No visible change in the
"appearance of the carbon. No blackening of
"the bulb. Exhausted April 2d. Vacuum tested
"April 17th and showed remarkably high exhaus-
"tion.

"Lamp No. 5. Silk-thread carbon. Nitrogen
"atmosphere. Burned for one hundred and thirty-
"eight hours and is still in perfect condition.
"Charged with nitrogen April 5th. Tested April
"17th, at which time it showed evidence of per- 5579
"fect nitrogen atmosphere of low pressure.

"Lamp No. 6. Bottle-stopper lamp. Carbon
"of piazava, platinum clamps. Exhausted to high
"vacuum. Thirty candle power. Was run for
"twenty-four hours and twenty minutes at about
"twenty candles and is now in perfect condition,
"both as to vacuum and condition of carbon."

39 Q. From your experience in connection with the
Sawyer-Man lamps which you made as exhibits in the
said McKeesport suit, what is your opinion in regard 5580
to the practical character of lamps in which the globe
and base are joined and the leading-in wires are ar-
ranged in the manner of these exhibits, whether said
lamps are used either with an atmosphere of nitrogen
gas or with a vacuum.

A. My opinion is the same as I have already ex-

5581 pressed in my answer to question 8 in the McKeesport suit, which answer was as follows:

"The result of my work in the making of these "lamps has been to demonstrate beyond any doubt "the entire practicability of such a lamp structure. The matter that at first was considered of "the greatest difficulty in beginning the work, "namely, the preservation of an air-tight joint at the
5582 "base of the lamp, proved to be one which was "easily overcome by the exercise of ordinary care "and good workmanship in the preparation of the "parts, and by proper attention in the assembling of those parts. It was found that each "lamp could be made tight enough in the factory "to be practically tight when the parts were simply put together dry, relying only on the intimate contact of the flat surfaces for the joint. "On several occasions I so placed the parts together, and partially exhausted the lamp, when
5583 "it was found that a sufficient exhaustion was "maintained within the lamp in this way to firmly "hold the base plate in place for an hour or so; "in fact, this method was used frequently during "our work to test the accuracy of the workmanship on the lamps as they came from the factory. "It is quite evident when the matter is looked "into with a little care, that there is no serious "difficulty in this part of the work, the joints de-
5584 "pend entirely upon the intimate contact of flat "surfaces, not only between the flange at the bottom of the globe and the base plate, but also "between the flanges of the tube bolts and the base "plate. Nothing is easier in the line of mechanical "work than to grind surfaces practically flat, "assuming that suitable appliances are employed "for the purpose. It is well known that two "heavy metal blocks may be so accurately

"ground together that when placed in intimate 5585
"contact with each other, the air is so perfectly "excluded that it is possible to lift both blocks "by picking up either one of them, the atmospheric pressure holding them together as one "piece. It is entirely unnecessary to attain any "such degree of perfection in the contact of the "joints in an incandescent lamp, since the coating "of balsam used on the surfaces fills up any minute irregularities, and the result is that when two 5586
"surfaces are pressed together the air is excluded "and a perfect joint is obtained. A sort of molecular adhesion comes into action in addition to "the external pressure of the atmosphere, holding "the surfaces together with great force, so that "when once placed together it is nearly, or quite "impossible to remove one from the other by a "direct pull.

"The only other air-tight joints required are "the small valves in the tube bolts, and these 5587
"again are easily made tight by grinding in place "in the ordinary way; such valves are so common "as to require no explanation. The application "of a small amount of balsam around the valves, "when they are finally closed is sufficient to "insure their tightness.

"All of the particulars referred to above, as "will be seen, are simply matters of ordinary care "in the putting together of the parts, and are "such matters as any careful workman, as for 5588
"instance, an instrument maker, would attend to "as the result of his experience. The operations "are, however, so simple that they could be "readily learned by any person of average intelligence in a short time.

"It is, in my opinion more difficult, if any "difficulty is supposed to exist in producing a "tight joint, to produce a vacuum lamp than one

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"filled with an inert gas, since the joints are then
"subjected to the severest possible test. As will
"be seen by referring to the record of the tests of
"these lamps as it has already appeared in my
"testimony, the exhaustion of such lamps as were
"run in vacuo did not deteriorate in the least, even
"in cases where the carbons burned out within
"forty or fifty hours; most of the failures were due
"either to defective carbon, or over-running the
5590 "lamp for the sake of producing a brilliant effect.
"It was not thought that there would be any
"difficulty in obtaining a sufficiently good carbon,
"or in fact, in employing such carbons as are now
"used in incandescent lamps, if the lamp could be
"made perfectly tight; such proved to be the case,
"and little time was spent on the production of
"any particular kind of paper carbon, as it is a
"matter of common knowledge that paper carbons
"have been, and still are used commercially with
5591 "perfect success. A number of carbons were,
"however, prepared of various kinds of paper,
"including bond paper, cardboard and blotting
"paper. Most of the lamps prepared contained
"carbons of cardboard which was found to be
"easily prepared and convenient to use. The
"carbons in Exhibits 4 and 5 are of silk thread,
"prepared, carbonized and treated as for ordinary
"lamps made for the Westinghouse Company.
"One of these lamps is exhausted to as high a
5592 "vacuum as possible, and the other contains
"nitrogen. The purpose in the preparation of
"these lamps was to give as severe a test as pos-
"sible to the tightness of the joints, since any
"leakage whatever, would very noticeably affect the
"surface of these carbons of small diameter and
"cause them to burn out. No signs of burning
"out were shown at the end of 200 hours in the

"case of the exhausted lamp, and 138 hours in the 5593
"case of the nitrogen lamp, after which tests they
"were removed from the circuit, and immediately
"packed and brought here for the purpose of
"entering as exhibits. These lamps were run
"during the test at about the same temperature as
"other lamps undergoing test at the same time
"and which were the same as used commercially
"at the present time."

40 Q. How would the cost of such Sawyer-Man 5594
lamps, if made on a commercial scale, compare with
the ordinary incandescent lamp of the present day?

A. In answer to this question I will quote my answer to question 9 in the McKeesport suit, as my opinion is now the same as there stated. This answer is as follows, the references to "the patent in suit" being in this answer, as in my answer to Q. 38, to the Sawyer-Man patent No. 317,676:

"The comparative cost would depend very
"greatly on the amount of light obtained from 5595
"the lamps in question; the cost of the two
"kinds of lamp approaching more nearly in lamps
"of higher candle power. By far the greater num-
"ber of lamps, however, are of 10, 16 and 25
"candle power as used commercially at the pres-
"ent time, so that it will be proper first to con-
"sider a comparison of such lamps. I am
"informed that the cost of producing ordinary
"incandescent lamps is roughly between twenty
"and thirty-five cents, according to the exact 5596
"style of the lamp, the current carried in its in-
"candescent carbon and consequent size of the
"platinum wires.

"It is customary after such lamps are burned
"out to throw away the remaining part, since the
"value of the remaining material would be hardly
"greater than the cost of shipment and remodel-
"ing necessary before they could be again util-

5597 "ized. As a purely commercial matter it has been
"found that this is the most feasible form of lamp
"to use. I refer to the form in which platinum
"wires are sealed in through the glass, as in the
"old Geissler tubes and radiometers, and experi-
"mental apparatus of Crookes and others, well
"known prior to the invention of Sawyer and
"Man. The view taken by Sawyer and Man in
"their work was that a lamp should be so con-
5598 "structed that when the carbon should become
"destroyed by use, the other parts of the lamp
"might be returned, taken apart, and refitted with
"a new incandescent conductor for another period
"of use. Bearing this in mind, it does not ap-
"pear strange that they were willing to depend
"upon a more expensive form of lamp than might
"be obtained by utilizing the knowledge of the
"day in the sealing of wires through the glass.
"On the other hand, the expense of producing a
"lamp of the exact form shown in the patent in
5599 "suit would not be so great as to prohibit its use
"on a commercial scale, even if it were not gener-
"ally returned for remounting. From my expe-
"rience with such mechanical work, I would
"estimate that lamps of the Sawyer and Man form,
"as shown in the patent in suit, could be pro-
"duced complete in quantities of, say 1,000 or
"more per day, at a cost of between eighty cents
"and one dollar each. Of this cost sixty to
5600 "eighty cents would be that of the permanent me-
"chanical portions of the lamp, allowing twenty
"cents as outside estimate on the cost of taking
"apart, preparing and mounting a new carbon,
"putting together and re-exhausting. I believe
"it quite possible that on a large scale the cost
"would not be more than one-half of this amount.
"In the case of the larger lamps, of say from 50

"to 150 candle power, it is evident that little 5601
"would be added to the cost of the lamp of the
"old Sawyer-Man form, since the changes would
"be more in weight of material used than in
"labor, as compared with the small lamp. A
"lamp of the modern type, however, with the
"Geissler seal involves a greatly increased amount
"of labor by the glass-blower, as the size is in-
"creased, and runs up rapidly beyond the amount
"I have estimated, as the cost of the old Sawyer- 5602
"Man form.

"To summarize briefly: Lamps of the old
"Sawyer-Man type could be refitted for use an
"indefinite number of times at a cost not differing
"greatly from that of supplying modern incan-
"descent lamps, as is habitually done by the
"various electric light companies and without very
"greatly increasing the investment for the instal-
"lation of a plant in the first place. The cost of
"installation of an incandescent light plant may 5603
"be placed at from fifteen to twenty-five dollars
"per lamp as now practiced commercially. Even
"an addition of one or two dollars in the amount
"of this investment would not seriously change
"the commercial value of the lamp since renewals
"of carbon would cost practically the same, or
"less than the present renewal of the entire lamp."

41 Q. At what date did you give your testimony in the McKeesport suit in regard to those lamps?

A. It was given on April 19, 1889.

42 Q. Have you recently tested those six Sawyer- 5604
Man lamps which were made exhibits in the McKeesport suit?

A. I have within the past two weeks.

43 Q. What do you find to be their present condition compared with their condition when put in evidence in the McKeesport suit on April 19, 1889?

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A. A test of the exhaustion of the globes by means of an induction coil showed that the vacuum had remained practically the same as when they were first tested, and by passing a current through the conductors of lamps Nos. 2, 3, 4 and 5, sufficient to bring the carbons to proper incandescence, they were found to operate as well as before. Nos. 1 and 6 could not be so tested, as the carbons had been accidentally broken since the time when they were put in evidence.

5606 44 Q. Do you know how the carbons in lamps Nos. 1 and 6 were broken?

A. No, I do not.

45 Q. Is it a common occurrence in the handling and transportation of ordinary commercial lamps that the carbons become broken?

A. Yes, the carbons of incandescent lamps are easily broken by any sudden and violent shock.

Defendant's counsel offers in evidence the
5607 Sawyer-Man lamps testified about by the witness, and the same are marked respectively, "Defendant's Exhibits, Shallenberger's Sawyer-Man lamps 1, 2, 3, 4, 5 and 6.

Defendant's counsel also offers in evidence the lamp testified to by the witness in answer to question 33 and the same is marked "Defendant's Exhibit Lamp with Sawyer-Man Carré carbon."

5608 46 Q. Please examine the two lamps now produced and state whether they were made under your superintendence?

A. Yes, they were.

47 Q. Please give the measurements of these lamps as regards the carbon, candle-power, and current required to bring them to their standard candle-power.

A. The carbons are of the same length—about $7\frac{1}{4}$ inches each—and the diameters are the same,

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namely, seventy-three ten thousandths (.0073) of an inch. The resistances are eighty ohms and three hundred and thirty ohms respectively. At sixteen candle-power, the lamp having eighty ohms resistance requires an electromotive force of forty-nine volts with a current of one and twenty-six hundredths (1.26) amperes. The carbon having a resistance of three hundred and thirty ohms requires an electromotive force of one hundred and twenty-seven volts at sixteen candle power, and a current of six- 5610
ty-one hundredths of an ampere. These two carbons illustrate the great difference in specific resistance that can be obtained in different specimens by differences in the treatment of the carbon after carbonization. The dimensions being practically the same, the specific resistance would be in the ratio of the total resistance of the carbons, namely, eighty to three hundred and thirty. Each of these lamps is a good practical lamp adapted to be run at sixteen candle power on a circuit supplied with current of proper electro-motive force. 5611

48 Q. How did you produce the difference in the specific resistance of these carbons?

A. The carbon of higher resistance was produced by treating a carbonized silk thread to an amount sufficient to consolidate its structure without sensibly increasing its diameter, thus maintaining a large proportion of its original resistance. The carbon of low resistance was obtained by taking a smaller diameter of carbonized silk and treating it up to the same diameter as the first, thus greatly reducing its resistance. The 5612
subsequent treatment of these carbons was the same as ordinarily practiced.

Defendant's counsel offers in evidence the two lamps last described by the witness, and the same are marked Defendant's Exhibits, "Shallenberger low-resistance lamp," and "Shallenberger high-resistance lamp."

5613 Defendant's counsel also offers in evidence the paper heretofore referred to as "Complainant's List of Edison Lamps," and the same is marked "Defendant's Exhibit, Complainant's List of Edison Lamps, S. M. H., Exr."

It is admitted by counsel for complainant that this list represents with substantial accuracy the various commercial types of incandescent lamps made within the past three years by
5614 the Edison Electric Light Company, complainant herein—the various measurements of the lamps, current, etc., being as set forth in the said exhibit.

Adjourned to January 23, 1890, at 11 A. M.

NEW YORK, January 23, 1890.

5615 Met pursuant to adjournment.

Cross-examination of OLIVER B. SHALLENBERGER, by MR. DYER:

49 x-Q. In answer to question 2, you speak of having been associated with Mr. Alexander de Lodyguine, what year was this?

A. It was during part of 1888 and 1889.

50 x-Q. With reference to the lamps described by you in answer to question 8, you say that "some of
5616 them (or rather duplicates of them) have been run some sixty or seventy hours;" what is the fact in respect to the identical lamps offered in evidence?

A. The lamps offered in evidence have been run at high incandescence on the pumps during exhaustion, as usual, for two or three hours and subsequently for a short time during photometer tests.

51 x-Q. Is that the extent of the use of the current with all of the lamps offered in evidence after answer 8?

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A. Yes, that is the case; the lamps offered in evidence are taken from lots of lamps made at the same time and by the same methods. A set was made up by a selection from these lamps, some of which were put on tests. Similar lamps were selected to put in evidence, as the time was too short too carry out any life-tests on the identical lamps before their removal from the factory.

52 x-Q. The running on the pumps is a step in the process of manufacture before the lamps are completed by sealing, is it not? 5618

A. Yes.

53 x-Q. Was this step in the process of manufacture carried on in your usual manner with your commercial lamps?

A. Yes. There was no difference except in the length of time required for carbons of different diameters. Large carbons require more prolonged heating at a very high temperature in order to obtain a proper exhaustion.

54 x-Q. In this manufacturing process, how is the 5619
current varied, if at all, in its application to the lamps? Please give the various strengths of current and degrees of incandescence and the length of time approximately that each is used?

A. Taking, for example, a carbon of one and a half millimeters diameter, the current first applied, after the preliminary exhaustion has been completed without heating, is sufficient to bring the temperature of the carbon to a point at which it becomes visibly red; af- 5620
ter a few minutes' pumping at this temperature the current is increased to bright redness so that the amount of current passing is nearly as great as would subsequently be required for the operation of the lamp at normal candle-power. After the exhaustion at this temperature has been carried on for a short time, the current is again increased to a degree sufficient to heat the carbon far above its proper incandescence when

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running normally; after running a sufficient time at this temperature, to complete the exhaustion of the gases driven off, the seal is completed, the current shut off, and the lamp removed from the pump. During the half hour or more during which the temperature is highest, the leading-in wires, the carbon and the whole lamp-structure are subjected to a very severe strain which is apt to develope any defects that may have occurred in the making of the lamp.

5622 55 x-Q. What length of time is the dull red heat maintained, and also the bright red heat?

A. In ordinary cases about half an hour each, where the carbon is large.

56 x-Q. Then the three stages of incandescence, as I gather from your last answers, would occupy about an hour and a half for large carbons?

A. That is about as short a time as would be sufficient if the entire process were carried out as rapidly as possible. I think in most of the lamps offered in
5623 evidence after answer 8, the time was considerably longer than this as the lamps were of unusual types as compared with the usual product and were left on the pumps rather longer than customary. The length of time is governed by the action of the pumps by which the workman is enabled to judge of the degree of exhaustion.

57 x-Q. Please state with respect to the various lamps referred to in the tables contained in your answer 8, what the length of time was that the current
5624 was applied to the lamps during the pumping process, and how that time was divided between the three stages of incandescence?

A. I am unable to do this, as the time of heating was left to the judgement of the man in charge, and was determined by the degree of exhaustion as the work proceeded. I have answered in a general way from my observation of the work from time to time. The

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process was carried out in a manner so similar to the usual methods that it did not require my close supervision.

58 x-Q. In the carrying out of this process with the commercial types of lamps made by the Westinghouse Company, what is the length of time that the lamps are maintained on the pumps at or above their normal temperature?

A. Usually about half an hour, depending upon the observed action of the pump, and upon the size of the 5626
lamp-bulb.

59 x-Q. What is the same fact with regard to the making of the lamps referred to in answer 8?

A. The time was somewhat longer than this, and for the reason that many of these lamps were made with unusually large carbons. With such lamps as correspond more or less with the ordinary lamps manufactured, the time was about as I have indicated in my preceding answer.

60 x-Q. How much longer was it for the other lamps? 5627

A. I don't know exactly.

61 x-Q. State as much as you can?

A. I have previously stated as nearly as I am informed. The time I think varied from something less than an hour at a high temperature to perhaps two hours, unless for some reason it was necessary or desirable to continue the heating for a longer time. The lamps were often allowed to remain on the pumps until such a time as Mr. Smith or I could inspect them. It is, therefore, a matter about which I am unable to tes- 5628
tify with any degree of exactness.

62 x-Q. You speak of being *informed* in this matter, who, if anybody, *knows* the facts?

A. I was informed only by my own observation, and am not aware that any record was made by any one of the time of exhaustion or of heating. I would not feel at all confident of getting reliable information as to

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these special lamps, even from the man in charge of
the pumps, as he would have paid less attention to the
time that elapsed than to the condition of the vacuum
as the work proceeded.

63 x-Q. You state in answer 8 that duplicates of
some of the lamps were run "some sixty or seventy
hours." Have you a record of this which you are willing I should see?

A. The original record was made in Pittsburgh and I
have not in my own possession a copy of it. I have since
5630 been informed by the man in charge of the tests that
these tests have been continued up to the present time,
and that the lamp having the largest and longest carbon with leading wires of eighty thousandths (.080) of
an inch in diameter has now been running one hundred
and forty-eight (148) hours. I have a telegram just
received stating that this lamp had been running one
hundred and forty-eight (148) hours up to 3.30 P. M.
to-day. This lamp is burning at a temperature so high
that the globe and point of sealing-in the wires are
5631 excessively hot.

64 x-Q. To which lamp in your tables does the lamp
referred to in your last answer correspond?

A. It refers to the last lamp in series III, marked
570-E. This lamp is being tested at a current of about
twenty (20) amperes.

65 x-Q. That is, it is being tested under practically
the same conditions as that indicated in your table
Series III?

A. Yes.

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66 x-Q. Is only one of these lamps like 570-E of
series III undergoing test?

A. Yes, that is the only one of exactly that type.

67 x-Q. How was it when the test started in regard
to the lamps?

A. The number of lamps was the same; none have
yet broken.

5633

68 x-Q. I notice in your tables that the candle-powers of the lamps are given irregularly. How did you
arrive at these candle powers?

A. The lamps when about to be measured for candle-power were brought up to what was considered a fair
degree of incandescence as indicated by the apparent
temperature of the carbon; the measurements were
then made without any attempt to force them into a
regular succession.

69 x-Q. What indications governed you in fixing this 5634
candle-power, if any?

A. The temperature at which the carbon appeared
to be burning, and in the case of the largest carbons.
the appearance of the joints with the platinum wires,
It was not deemed advisable to heat either the joints or
the leading wires too highly, although I have sometimes
passed a sufficient current to heat these to redness
without injuring the seal.

70 x-Q. What was the appearance of the joints with
the platinum wires which guided you in fixing the can- 5635
dle-powers of the lamps with the largest carbons?

A. The temperature of the carbon might be raised
so high as to heat the joint to a degree sufficient to
endanger its continuity. Any tendency in this direction was guarded against for fear of producing a failure at this point in subsequent tests; if, however, any
defect had occurred at the joints, the remedy would have
been to make them more perfect in new lamps made
up to replace them.

71 x-Q. The breaking of the continuity at the joints 5636
by this excessive heating would result in the destruction of the lamp, would it not?

A. Yes.

72 x-Q. How long were the lamps, put in evidence
after answer 8, subjected to the photometer?

A. Some of them only a minute or two, and others,
particularly the first of each type measured, may have
remained for five or ten minutes perhaps.

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73 x-Q. I refer to the identical lamps put in evidence, please state the same fact with respect to these particular lamps.

A. I cannot state any more definitely than this.

74 x-Q. How many of the largest sizes of these lamps did you make or attempt to make ?

A. Three or four of each size.

75 x-Q. Who worked upon the carbons and the glass-work of the lamps referred to in question 8, and
5638 who upon the other operations of manufacture of these lamps ?

A. Most of the glass-work was done by a workman employed for experimental work, whose name is Emil Greiner. A number of the seals, by which I mean the attachment of the leading-in wires to the glass surrounding them, were made by a boy employed as a lamp-maker and who sometimes assists in doing the easier parts of experimental work. The special bulbs were blown from tubing by Greiner. The treatment of
5639 the carbons and mounting on the platinum leading wires and cementing were done by persons ordinarily employed in doing such work whose names I do not know. Mr. E. E. Cary may have done some of the treating or other work connected with the carbons, but I do not know that he did. Mr. Cary is foreman of the carbon department.

76 x-Q. Is it not a fact that some of the lamps put in evidence after answer 8, among those having the platinum leading-in wires, show evidences of fracture
5640 of the glass in the vicinity of these wires ?

A. I have noticed in two of these lamps cracks at or very near the inner end of the seal, at which point the heat radiated and conducted from the carbon is the greatest. This often occurs in the lamps of one hundred and fifty (150) candle power which have been manufactured by the Westinghouse Company, but such cracks do not impair the continuity of the seal lower down.

77 x-Q. The one hundred and fifty (150) candle- 5641
power lamps you refer to have carbon burners and platinum leading wires of larger diameters than the corresponding parts in commercial lamps made by that company which approach more nearly the candle power of the ordinary gas burner ?

A. Yes.

Adjourned to 24th inst., at 11 A.M.

New York, January 24, 1890. 5642

Met pursuant to adjournment.

Present : Clarence A. Seward and Richard N. Dyer for complainant,

Samuel A. Duncan and Leonard E. Curtis for defendant.

78 x-Q. What is the treatment you refer to in an- 5643
swer 11, as essential to a useful incandescent lamp ?

A. I referred in this answer to treatment by passage of a current during the process of exhaustion.

79 x-Q. That is not the same treatment as the hydro-carbon treatment referred to in question 11 ?

A. No, it is not.

80 x-Q. One, which we will call treating during exhaustion, drives out the gases by the heat without adding material to the carbon, while the other, or hydro-carbon treatment, produce a deposit of carbon upon the 5644
burner ?

A. Yes, that indicates in a general way the difference between the two processes.

81 x-Q. Which of these two treatments do you refer to in answer 12 ?

A. I referred to both methods in that answer, and I meant to say that the carbon, without some process applied to it subsequent to carbonization, either hydro-

5645 carbon treatment or heating on the pumps, or both of them, or at least something to take the place of these processes, would not be in good condition for use.

82 x-Q. Both of these processes are not in use by all manufacturers of commercial lamps, are they?

A. No. I do not think so.

83 x-Q. Is either in universal use, as far as you know. If so, which?

A. I believe, although I do not know certainly, that
5646 all makers of incandescent lamps use the process of heating during exhaustion.

84 x-Q. This is essentially a different process from the hydro-carbon treatment, is it not?

A. No; it is not different in all respects, as the question might lead one to infer, as there are many effects produced in either process of more or less the same nature. For instance, if a carbon is put into a lamp without any treatment subsequent to carbonization, the heating on the pumps takes the place of a part of
5647 the work that incidentally occurs during the hydro-carbon treatment, namely, driving out gases which would otherwise be driven off during exhaustion and consolidating the fiber of the carbon independent of any deposit that may occur. Separating this effect from the hydro-carbon treatment proper, although in point of fact they are quite inseparable, it may be said the two processes are entirely different.

85 x-Q. As a matter of fact manufacturers who use the hydro-carbon treatment also use the other process
5648 in the same lamps, while commercial lamps are manufactured without using the hydro-carbon treatment?

A. Yes; this corresponds with my knowledge of the subject.

86 x-Q. Were not both these processes, *i. e.*, a hydro-carbon treatment and the heating during exhaustion, known to the art prior to filing the application of the patent in suit; that is, prior to November 4, 1879?

A. Yes, I believe this to be the fact. 5649

87 x-Q. Are the lamps referred to in answer 16 as having been produced by you, the lamps referred to by you in answer 8?

A. Yes, I referred to lamps covering that range of dimensions, and the lamps described in answer 8 are part of the lamps mentioned in answer 16, and of the same general types, and practically of the same construction.

88 x-Q. What method of joining the carbon burners 5650
to the platinum leading-wires did you employ in making these lamps?

A. They are attached by use of a carbon cement applied by immersing the carbon, mounted mechanically in tubular ends formed on the platinum wires, in a hydro-carbon liquid, and while immersed passing a current through the joint sufficient to heat it to redness and deposit carbon upon the joint and cement the carbon and platinum together.

89 x-Q. How is the current confined to the joints in 5651
this process, if it is?

A. Either by short-circuiting the loop, in case the carbon is of this form, or by making a contact from one of the conductors to a point on the carbon near the joint and completing the circuit through the platinum leading-wires.

90 x-Q. How was this done in making the lamps referred to in answers 8 and 16?

A. I do not know the exact connections used. They
were arranged by the workmen at the time as in the 5652
usual practice of this process. There is some choice of the precise arrangement best suited to the size of the carbon, but I am not able to testify definitely on this point.

91 x-Q. You understand, however, that the connections employed for this purpose in your commercial manufacture, or connections answering the same purpose, were used for these lamps?

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A. Yes; the arrangement consists in a simple cross-contact or "ridge" held lightly in place by a spring across the two ends of the carbon, so that when a current is passed through the platinum wires, it traverses one wire, then the joint, then the bridge, then the other joint, and then the second platinum wire. The resistance of the bridge is so low that nearly all the current passes across it instead of the carbon, and its points of contact with the carbon are so close to the joint that the heat generated at the contact, if any,
5654 aids in forming the joint.

92 x-Q. How long have you been acquainted with this process of making the joints between the carbon burner and the leading-wires?

A. I found it in use in the electric lighting department of the Union Switch and Signal Company when I first began work there in the fall of 1884. I do not know how long before this time it had been in use.

93 x-Q. Do you know that it is found described in the literature of the art prior to the date of the patent
5655 in suit, January 27th, 1880?

A. I have never made a search on this point and do not know that it is.

94 x-Q. In your answer 24 you give the sizes of platinum wires ordinarily used; are these the sizes used in the commercial types of lamps of the Westinghouse Company?

A. They are for the smaller sizes of lamps; in the larger sizes of lamps wires up to .033 of an inch are used.

5656 95 x-Q. Please state what are the sizes of the carbons in the several types of commercial lamps made by the Westinghouse Company, also the sizes of the platinum wires for these lamps respectively?

A. In reply to this question I submit the following tabular statement. The diameters given are approximate to the nearest thousandth, as I have not at hand

5657

more accurate data. The lamps of one hundred and fifty (150) candle-power are obtained by mounting two carbons of 75 candle power each, in the same lamp.

TABLE OF MEASUREMENTS.

Candle Power.	Volts.	Diam. of Wire.	Diam. of Carbon.	
10	100	.014"	.0055	
16	100	.014"	.007 "	
25	100	.016"	.008 "	
10	50	.016"	.006 "	
16	50	.016"	.009 "	
25	50	.018"	.011 "	5658
32	100	.016"	.010 "	
32	50	.020"	.0125"	
50	100	.018"	.013 "	
50	50	.022"	.014 "	
75	100	.028"	.016 "	
75	50	.033"	.018 "	

96 x-Q. Please state what is the relative importance in your business, *i. e.*, that of the Westinghouse Company, of these various styles of lamps, that is, approximately the relative percentages sold?

A. I can only answer this question in a very general 5659
way, as I am not in a position to require accurate information on this point. The lamps of sixteen (16) candles power are much more generally used than any of the others; next to these I believe the twenty-five (25) candle power lamps are most used. The remaining lamps are all used in large quantities, but I am unable to give the exact numbers.

97 x-Q. What are the regulating methods and apparatus introduced into the art since 1880 which you refer to in answer 17?

A. I referred principally to the three-wire and mul- 5660
tiple-wire systems, by which it is possible to distribute current under electrical pressure two or more times greater than the highest pressure for which any lamp in the system is adapted. This device is in reality a modification of what is known as "multiple-series connection." I referred also to the

5661 use of feeding circuits into which are introduced more or less resistance in order to preserve equality of pressure at different points. These constitute the principal improvements in the use of continuous currents, although there are a large number of additional devices that go to complete the equipment of a central station.

98 x-Q. I understand that you have testified in another case that your practical experience in electric
5662 lighting began in the year 1884. Upon what do you base your knowledge of what has been introduced into the business subsequent to 1880 and what was known in the business before that date?

A. I base my knowledge on published accounts of the state of the art from time to time in electrical journals and patent specifications. I have, since 1880, been interested in electrical work, although not practically engaged in it prior to 1884.

99 x-Q. With reference to the defendant's lamps,
5663 which you say in answers 21 and 22 are not practically useful for central-station distribution without the employment of some system of electrical distribution not practiced or known to the art in the year 1880, what system of distribution did you have in mind as known in 1880?

A. A dynamo connected to conductors, which conductors were connected to lamps or other devices in operation in multiple arc.

100 x-Q. That is a system used very largely even to
5664 the present time for working a large number of lamps located in the same building, that is, what we know as an isolated plant?

A. Yes.

101 x-Q. And lamps of as low resistance as the defendant's lamps referred to in answers 21 and 22 are still used extensively in such plants?

A. Yes, such lamps are in use to a considerable extent in plants of this character.

5665

102 x-Q. You do not mean to take the position by your deposition that if lamps of no higher resistance and voltage were obtainable at the present time, the defendant's lamps referred to in your answers 21 and 22 could not be worked in great numbers in multiple arc both for isolated and central-station plants and assure good commercial results, without employing any system or methods or apparatus introduced into the art since the date of the patent in suit?

A. I do most positively take that ground in the 5666
sense fully indicated in my previous answer.

103 x-Q. In what sense and to what extent would such lamps be commercially useful were lamps of no higher resistance and voltage obtainable?

A. They would be commercially useful in what might be called selected districts, for lighting a number of large buildings within a few hundred feet of each other, but would fail to be commercially successful on any scale approaching what is done in gas distribution or in the present systems of central-station 5667
electrical distribution.

104 x-Q. Even at the present time, the central-station electric light plants do not compare in extent of distribution with gas plants do they?

A. I have the impression that they do compare very favorably, inasmuch as lights are now supplied to distances of two to three miles or more from the central stations.

105 x-Q. The fact is, however, that the majority of 5668
central-station electric light plants in use at the present time are smaller in capacity and area covered, than is the case in gas plants?

A. If this question is intended to mean whether there is more lighting at the present time by gas or electric lights, I would answer with no hesitation that gas distribution is at the present time much more extended. I believe, however, that this is dependent entirely in the present state of the art, on the extent of the market for lights at the prices charged by the com-

5669
panies, and not on the capabilities of the present systems of distribution to compete with gas distribution both as to distances covered and cost.

106 x-Q. Returning to the conditions stated in answer to x-Q 103, under which you state the defendant's lamps referred to in answer 21 and 22 would be commercially useful, I understand you give in answer to x-Q 103 the conditions of commercial utility in central-station plants. Would not these conditions also include isolated plants?

5670 A. That answer naturally includes any isolated plant, since the conditions are practically the same as described in answer to x-Q 103. In other words, such lamps would be useful wherever the source of current could be located near the lamps, as distinguished from a plant in which; after locating the generators, lamps could be supplied wherever the demand might spring up within reasonable limits.

107 x-Q And plants of the former character are in extensive use even to the present day?

5671 A. Yes.

108 x-Q. You state in answer 20 that any incandescent lamp having a resistance of less than 100 ohms hot, would not have been practicable for central-station lighting with the mode of distributing the electric current known in 1880. Would such a lamp be practible for central-station lighting now, and if so, what makes it practicable?

A. Such a lamp would not be practicable now except by the use of methods of distribution introduced since
5672 1880, and by the use of such methods it has become practicable to use lamps of this or even lower resistance with success. The systems now in use have been gradually evolved by experience in the requirements of electrical distribution, resulting in a number of inventions, such as I have before referred to, and others, by which the distributing pressure is more or

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less independent of that required by lamps. It would in fact require a lamp of much higher resistance than 100 ohms to make multiple-arc distribution, in the form known prior to 1880, available for central-station distribution.

109 x-Q. Is there any central-station system of distribution, using in the lamps the current directly obtained from the source, known at the present time, capable of using a lamp of less than 100 ohms resist-
ance hot? 5674

A. None, except series systems, or systems involving the use of multiple wires to an extent that I believe would be almost impracticable.

110 x-Q. Do you include in your last answer such a central station as is used by the Edison Company in the lower part of New York City as one in which lamps of less than 100 ohms resistance hot could not be practically employed?

A. In answering this question I must refer, in order
not to be misunderstood, to the answer to question 19 5675
in which I have specified that lamps giving a light comparable in amount to that of ordinary gas gets are being considered. It would not be, and is not, I believe, practicable to use lamps of less than 100 ohms giving such an amount of light on the circuits of the station referred to in this question.

111 x-Q. You do not intend then that your answer to question 20 should be taken without limitations?

A. No, I intended it to be limited by the term cent-
ral-station lighting defined as in answer to question 19, 5676
since the vast majority of lamps used in central-station lighting are intended to give a light about equivelant to a gas jet.

112 x-Q. How large a lamp in candle-power did you mean to include in the opinion expressed in answer 20?

A. Lamps not greater than say 25 candle power, al-

5677 though I am aware larger amounts of light are often required from a single lamp, but the fact will be found as I have stated, I think, that the average lamp would be not far from 16 candle power.

113 x-Q. You do not include lamps of 32 candle-power or larger?

A. I include all lamps in the average assumed, since the number of lamps larger than 25 candle power is comparatively limited. What I mean to have understood is, simply that the requirements for central-
5678 station lighting are such as to need a lamp in nearly all cases of more than 100 ohms resistance, the number of lamps of less resistance being comparatively so small as to not greatly affect the average. A central-station depending entirely or mainly on lamps of lower resistance would be unable to supply lights sufficiently small to meet the demands of the business.

114 x-Q. Nevertheless you know the fact to be, that lamps of considerably less resistance than 100 ohms hot have been in the past, and still are, used in large
5679 numbers in the central-station plant referred to by me in x-Q. 110?

A. I believe this to be the case, and would have no hesitancy in saying that lamps as low in resistance as five ohms, for example, or even much less could be used with most perfect success and in large numbers.

115 x-Q. Even accepting your limited view of central-station lighting as intended to be included in your answer No. 20, lamps of under 100 ohms resistance hot would have been practicable by employing a
5680 multiple-series system, would they not?

A. Yes, in a limited way.

116 x-Q. The multiple-series system was known in 1880, was it not?

A. I believe it was, but not in any definite application to electrical distribution as a complete, working system.

5681

117 x-Q. Is it not a fact that lamps of less than 100 ohms resistance hot were in use, arranged in multiple series, in 1880, and are at the present time extensively used and supplied with current from central stations?

A. Yes, understanding that "extensive use" and "from central stations" apply to the present practice, and not to that in use in 1880.

118 x-Q. That is, you know that to be the fact at the present time, but you do not know that the system was in extended use from central stations in 1880? 5682

A. Yes.

119 x-Q. Referring to your answer to Q. 32, was the Bernstein lamps or the Edison Municipal lamp known in the year 1878?

A. No.

120 x-Q. Were they, so far as you are aware, known before the date of the patent in suit?

A. No.

121 x-Q. Referring to your answer to Q. 32, did you consider that the length of the piece of carbon 5683
sent to you by Mr. Curtis was significant, or did it appear to have been broken from a longer piece of Carré carbon?

A. It had the appearance of ordinary Carré carbon, and as such I presumed it had been broken from a longer piece.

122 x-Q. You say in answer 33 that "it was mounted." Do you mean that you mounted it?

A. It was mounted in the carbon department at Pittsburgh after it was received. When I received it 5684
it was simply a piece of carbon.

123 x-Q. When did you do this?

A. About two or three weeks ago.

124 x-Q. How extensively was the exhibit tested?

A. It was tested only a length of time sufficient to obtain the data Mr. Curtis requested.

5685 125 x-Q. The exhibit, with the exception of the carbon, I understand to have been made in the way you employ with your commercial lamps at the present time?

A. Yes.

126 x-Q. How did you ascertain the similarity in quality referred to in answer 35?

A. By the general appearance and my experience with carbons generally.

5686 127 x-Q. Did you make any electrical tests to ascertain the similarity?

A. No, I made no tests except of the piece sent me by Mr. Curtis, which I ascertained to be similar to ordinary Carré carbon.

Adjourned to January 25th, at 11 A. M.

NEW YORK, January 25th, 1890.

5687 Met pursuant to adjournment.

Present: CLARENCE A. SEWARD and RICHARD N. DYER, ESQUIRES, for complainant; SAMUEL A. DUNCAN and LEONARD E. CURTIS, ESQUIRES, for defendant.

128 x-Q. You state that your answer to Q. 38 is, so far as it relates to the six lamps referred to, the same as your answer to Q. 4 in the McKeesport case, being in fact a copy of a portion of that answer. Is not Q. 4 of the McKeesport case to which that answer was originally given, as follows:

5688 "Q. 4. Will you please produce samples of the "lamps made by you in accordance with the pat- "ent in suit, and describe the same both as to con- "struction and any tests and uses you made of "them, fully and in detail; and also any other "lamps of the same character made by you in "addition to those which you produce in evi- "dence?"

A. Yes.

5689

129 x-Q. And the patent in suit referred to in Q. 4 of the McKeesport case is the Sawyer-Man patent No. 317,676?

A. Yes.

130 x-Q. I quote from your cross-examination in the McKeesport case the following questions and answers:

"32 x-Q. What experience had you in the sub-
"ject of electric lighting by incandescence prior
"to 1880?

"A. None. 5690

"33 x-Q. When did your first acquaintance
"with the art of electric lighting by incandescence
"begin?

"A. My first acquaintance was the experi-
"ments I have referred to, in the winter of 1880
"and 1881, in the physical laboratory in the
"Naval Academy at Annapolis, Maryland.

"34 x-Q. Under whose directions and for what
"purpose were these experiments then made, and
"how long did the same continue? 5691

"A. They were not made under any one's direc-
"tion, but I was allowed to use the laboratory
"there in connection with my work as a student,
"and I obtained a copy of the Maxim specification
"describing his process of carbonizing paper. I
"undertook to see if I could do it.

"35 x-Q. How many lamps did you successfully
"make?

"A. I had only one lamp globe, and the attached
"mounting devices. I had several of the carbons 5692
"I had tested in it, none of which, that I remem-
"ber of, were particularly successful.

"36 x-Q. Just the college experiments of a
"young man of 20, were they not?

"A. They were hardly the sort of experiments
"that were usually made by students at the
"Academy, and would not have been made had I
"not been personally interested in the subject."

5693
"52 x-Q. Please state the numbers of the prior
"patents to Sawyer and Man which you for any
"purpose consulted in order to derive informa-
"tion for your experiments on the Sawyer-Man
"lamp?

"A. No. 205,144 and 210,809.

"53 x-Q. What patent did you consult for the
"method of treating the carbon adopted by you?

"A. No. 211,262, dated January 7th, 1879, to
5694 "Sawyer and Man.

"54 x-Q. In treating any of the carbons did
"you surround or saturate them by a carbon or
"hydro-carbon liquid?

"A. They were surrounded by hydro-carbon
"vapor or gas.

"55 x-Q. What pressure on the air-pump was
"indicated corresponding to the tension of this
"hydro-carbon gas during the period of treat-
"ment?

5695 "A. All the treatment was done at very low
"pressure, say below half or three-quarters of an
"inch.

"56 x-Q. That is to say you only had from
"about 1-48th to 1-64th or less of an atmosphere?

"A. Yes, that is substantially correct.

"57 x-Q. As I understand you, your object in
"treating in this attenuated atmosphere of hydro-
"carbon gas was to obtain a deposition of artificial
"carbon within the substance of the material
5696 "without increase of exterior diameter, or super-
"position of artificial carbon upon the outside of
"the material, except to a very slight extent.

"A. Yes, so that there could be no question as
"to the kind of carbon which composed the fila-
"ment; in other words, I did not want a carbon
"made up of an internal core and an external
"shell.

5697
"58 x-Q. And that carbon composed of an in-
"ternal core and an external shell, was what you
"sought to avoid, was it not?

"A. It was, exactly.

"59 x-Q And you sought to introduce the for-
"eign or deposited carbon within the internal
"core or cavity of the vegetable material used by
"you?

"A. I sought to produce an elastic metallic
"condition of the carbon characteristic of treated 5698
"fibrous carbon. The question as to whether gas
"is internally deposited, or whether the new con-
"dition of the carbon is the result of electrical
"heating in the presence of the hydro-carbon gas'
"did not enter into the question. What I wanted
"was a treated carbon that had the characteristics
"described by Sawyer and Man as the result of
"treating, and which nobody could accuse of be-
"ing principally composed of built-up carbon.

"60 x-Q. And when you treated the pencils of 5699
"carbon in order to show the difference of effec-
"tive treatment upon vegetable carbons and the
"pencils of carbon, you used the same method of
"treatment which consisted in heating these ma-
"terials in a highly attenuated atmosphere of
"hydro-carbon gas, is that not so?

"A. That was the principal experiment but
"not the only one. The particular carbon offered
"in evidence was treated in this way. I also
"treated others at different pressures of gas with 5700
"different currents, and for longer and shorter
"times, but found that while I could deposit an
"external shell, I could not render the carbon
"tough and elastic without thickening it.

"61 x-Q. But all the methods of treatment
"adopted by you, were methods of treatment with
"hydro-carbon gas, were they not?

5701
"A. Yes, I do not pretend to say that there "may not be some means of changing the physical "properties of hard carbon.

"62 x-Q. This treatment of the carbons in the "attenuated carbon gas—was it done before or "after the carbons were mounted in position in "the lamp?

"A. It was done before mounting.

"63 x-Q. What treatment were the carbons "subjected to after mounting and before the
5702 "lamps were sealed?

"A. They were heated to drive off occluded "gases.

"64 x-Q. In what atmosphere were they heat- "ed to drive off the occluded gases?

"A. Some in vacuo, some in nitrogen.

"65 x-Q. How did the process of treating the "carbons adopted by you differ as to its means "and apparatus from the method adopted for the "treatment of carbons commercially by your own,
5703 "or the connected companies at the present day?

"A. I decline to answer that question unless "instructed to do so by my attorney, as it involves "methods and processess which I cannot make "known.

"64 x-Q. Without asking you to reveal trade or "manufacturing secrets, or to give me the full par- "ticulars of the method adopted by you in the pre- "paration of the carbons used in your experi-
5704 "ments on the Sawyer-Man lamps, I would like "to know whether that method of treatment was "the same, or different from, the method of treat- "ment adopted commercially by your company "and the connected companies at the present "day?

"A. While the general process was more like "than unlike the present methods, it is necessary "to say that a large number of improvements have

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"been instituted in the methods of treatment, some "of which are at present availed of, and which "were not indicated definitely in the Sawyer- "Man patents. Any such methods as were "thought to be in the nature of improvements on "the Sawyer-Man method as described in the "patent were carefully avoided, and only such "precautions adopted as would naturally be pre- "sented to anyone of average skill and ability.

"65 x-Q. As I understand you, in treating your 5706
"carbons for these experiments, you avoided the "manufacture of a hard, dense carbon, and en- "deavored to preserve the elasticity and flexibility "of the original vegetable carbon as much as was "possible; and in order to avoid the accusation of "adding a foreign carbon to the incandescent "burner?

"A. Yes, that is substantially the case. I was "particularly anxious to avoid building up a solid "mass of deposited carbon independent of the 5707
"fibrous structure.

"66 x-Q. And by securing the internal deposit "of artificial carbon, you lowered the electrical "resistance of the burner to varying extents, de- "pending upon the porosity of the substance "treated by you?

"A. Yes, that was the case, and I might add, "depending also upon the susceptibility of the "fibre of the material used in each case for con- "solidation and tempering, as it is termed in the 5708
"specification.

"67 x-Q. And you found that blotting paper, "by reason of its loose matted nature and extreme "porosity, allowed the deposition internally of a "larger proportion of artificial carbon, and conse- "quently evidenced the greatest diminution of re- "sistance by reason of the treatment?

5709 "A. The reduction of resistance in the blotting "paper seemed to be partially due to the internal "deposition of carbon and partly to some other "action of consolidating the fibre, I do not know "exactly in what proportion.

"68 x-Q. And how far this other action of con-"solidating the fibre is affected or controlled by "the simultaneous deposition of carbon within "the blotting paper, you cannot say?

"A. No. All I can say is, that I have succeeded
5710 "in notably reducing the resistance and hardening "and toughening blotting paper when heated in "an atmosphere of nitrogen. This I have already "mentioned in direct testimony.

"69 x-Q. When in the art was the process of "treating carbon by heating the same in an at-"tenuated atmosphere of hydro-carbon gas, as "pursued by you in your treatment of these "carbons introduced?

"A. That method is the one described in the
5711 "patent to Sawyer and Man, in which I did not "find any specific directions as to the pressure of "gas, leaving it to be inferred that the operator "can use such pressure as he finds necessary for "his purpose. My purpose in this work was to "obtain the advantages obtained in the Sawyer "and Man specification for the hydro-carbon "treatment of a fibrous carbon, and avoid pro-"ducing any effect which might be construed as
5712 "something apart from the just claim of the "patent in describing the effects as applied to "fibrous carbon only.

"70 x-Q. What specification do you refer to?

"A. No. 211,262, and the patent in suit.

"71 x-Q. Again I ask you when the process of "treating the carbons in an attenuated atmosphere "of hydro-carbon gas was first introduced or

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"known in the art?

"A. That I do not know.

"72 x-Q. And so far as you know is it not true "that the present method of treating by hydro-"carbon gas in an attenuated atmosphere is a "part of all the processes at present adopted?

"A. I believe the hydro-carbon gas used where "hydro-carbon treatment is employed in the "manufacture of carbons, is usually more or less "attenuated. 5714

"73 x-Q. And is not the advantage of that at-"tenuation the fact that it permits the access of "the gas to the internal pores of the carbon and "the gradual deposition under control of artificial "carbon within those pores?

"A. I believe those are the principal advan-"tages."

"74 x-Q. Do you find this process described "anywhere in the art prior to January 5th, 1880, "except as you may find the same described in 5715 "the Sawyer-Man patent 211,262?

"A. No, I do not know of any such description.

"75 x-Q. Referring you to the specification of "that patent, does not that specification direct "specifically that the treatment is to be in a car-"bon liquid and not in a carbon gas?

"A. I find in the patent in question, com-"mencing at the next to the last line on the 2d "page, the following statement: "but the carbon "prepared by our process before it is put in the 5716 "lamp does not blacken the inner surface of the "globe or lamp charged with nitrogen when heat-"ed by the current to drive out occult gases "during the ingress and egress of the nitrogen, "because in that case there is no carbon gas pres-"ent, and of course, no deposit; and we desire "also, to point out the fact that the consolidated

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"homogeneous carbon of our invention may be "produced by the electro-plating process as well "as by the electrical heating of a conductor in a "carbon gas or liquid." I consider this ample "evidence of the intent of the patentees to employ "gas in the treatment of the carbon, and consider "it always a matter of judgement as to what press- "ure of gas should be used. The use of hydro- "carbon liquid produces a more rapid effect and
5718 "is more likely to be superficial, which, I would "point out again, I wished to avoid, for the distinct "purpose of maintaining a fibrous structure and "a surface which could be seen to be that of a "fibrous material by casual inspection.

"76 x-Q. And you exercised the degree of judg- "ment known to you in the year 1889, did you not?

"A. I most certainly did.

"77 x-Q. Do you find anything in Letters "Patent No. 211,262, which directs or points you
5719 "to the use or treatment of vegetable carbon?

"A. No, I do not now recall anything in that "patent.

"78 x-Q. It speaks of the treatment of pencils "of carbon, hard carbon, does it not?

"A. I do not find in the patent referred to, any "limitation to hard carbon. And I see beyond "the middle of the second column of the first page, "the following statement: 'A pencil of carbon "immersed in a hydro-carbon liquid, and heated
5720 "to an extremely high temperature by the voltaic "current is not itself attacked, but decomposes "the surrounding matter the carbon of which "enters and fills up its pores to an extent impos- "sible except with matter, in a very attenuated "state.' I have carefully experimented with the "behavior of hard carbon in hydro-carbon gas, "and in spite of persistent effort to do so, have

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"failed entirely to produce any evidence of ab- "sorption of gas within the interior of this carbon. "I have varied the conditions in every way I could "think of to produce this result, the carbon always "remained granular in fracture, easily broken, and "presenting none of the characteristics of what we "may term internally-treated fibrous carbon. I "take this as distinct evidence of the fact that the "carbon pencil referred to in the patent in ques- "tion could not have been of hard carbon, or it 5718 "would not have been referred to in that way. "Sawyer and Man employed carbons in the form "of a pencil for some time after the use of fibrous "carbon, hence I see no reason to believe that the "description was intended to limit the process to "hard carbon.

"79 x-Q. All this little history of what Sawyer "and Man did, or did not do, you find set forth in "the specification of Letters Patent 211,262?

"A. I find the quotation that I made in my last 5719 "answer contained therein; but not the remain- "der of my answer.

"80 x-Q. Now again I ask you, whether the "Letters Patent 211,262, does not specifically di- "rect the use of a liquid, and just as specifically "warn the reader against the use of a hydro-car- "bon gas, except as that gas exists within the "hydro-carbon liquid immediately in contact with "the incandescent carbon?

"A. The patent, as I read it, while it does 5720 "direct that the hydro-carbon liquid may be used, "contains no warning against treating in the pre- "sence of hydro-carbon gas.

"81 x-Q. This is your impression derived from "a study of the patent?

"A. I certainly interpreted no part of the pat- "ent in that way. That is my impression.

5721
"82 x-Q. As I understand you, you never used
"this Sawyer and Man process to create a homo-
"geneous exterior deposit, but confined your
"treatment to filling up the pores?

"A. None of the lamps offered in evidence con-
"tain carbon so treated. I, of course, do not
"wish to be understood as saying that there is no
"external coating whatever.

"83 x-Q. How many of the lamps presented by
"you in evidence have the metal clip or U-
5722 "shaped plate or holder at the bases of the arch-
"shaped carbon interposed between the carbon
"and the clamps as shown in figures 3 and 4 of
"the patent in suit?

"A. Two of them have sheet platinum inter-
"posed as indicated in the drawing: Pittsburgh
"Sawyer-Man lamp No, 1, and Exhibit Stillman
"lamp."

"84 x-Q. Which of the materials mentioned in
"the patent 211,262, as operating satisfactorily,
5723 "to wit: Naphtha, turpentine, bees-wax, balsam,
"and most oils, did you employ in treating the
"carbons in these experiments?

"A. In these particular experiments ordinary
"natural gas was used, as it was found to be a
"proper and good substitute for the vapor of hy-
"dro-carbon liquids.

"85 x-Q. When was natural gas first used for
"this purpose to your knowledge?

"A. It had frequently been used during the past
5724 "winter, and has been made use of in an experi-
"mental way before that time.

"86 x-Q. What is the earliest date, of which
"you know, of the use of that gas for these pur-
"poses?

"A. I do not absolutely know any date. I be-
"lieve we were using natural gas at least a year
"ago; but I cannot fix the date exactly.

5725
"87 x-Q. I fail quite to understand part of your
"10th answer as to the difficulty in building up
"a carbon by the super-position of a deposited
"shell. Will you kindly explain the reason of
"that difficulty, so that the Court may be able to
"understand it?

"A. The statement may in form be a little con-
"fusing; I did not mean to say that there was any
"difficulty in building up a carbon in this way, but
"meant to have it understood that there would
"be difficulty in getting the best results from a 5726
"carbon so built up, owing to the fact that the de-
"posited carbon is of much lower specific resist-
"ance than that of the fibrous core. The division
"of current would therefore be unequal between
"the two, and for a given quantity of current pass-
"ing over the carbon the outer shell would be
"carrying an unnecessarily large proportion, and
"the core would carry, perhaps, only a small part
"of what it was capable of doing. It seems evi-
"dent that in order to best utilize the entire 5727
"cross-section of a carbon the distribution of
"current throughout that cross-section ought to
"be about uniform.

"88 x-Q. As I understand you, it is the object
"of the modern manufacturer of carbons for in-
"candescent lamps to secure as nearly as possible
"a uniformity of resistance throughout the carbon
"and at all points of its cross-section?

"A. So far as I am informed I agree with you.

"89 x-Q. And so far as there is a deposition of 5728
"an external shell, this tends to prevent the at-
"tainment of such uniformity?

"A. Yes, I think that is true.

"90 x-Q. So that experience has shown that the
"deposition of an external shell is a disadvantage?

"A. I would not say generally that it is a dis-

5729

"advantage, because it may be very useful as a "means to a certain end where its advantages "would greatly overbalance its disadvantages. "Some forms of series lamps, for instance, are "built up, I believe, in this way to a considerable "extent, and with very satisfactory results; to "that extent I must qualify my former answer.

"91 x-Q. But in filament lamps, such as Com- "plainant's Exhibit, Defendant's Lamp, I under-
5730 "stand you that experience has shown that the "existence of an outer shell is a detriment to the "life of the lamp?

"A. I am not quite sure, after giving the matter "a little more careful thought, that this point is "recognized by manufacturers of incandescent "lamps; but I believe that it is really the case, "that a thick outer shell is a disadvantage for a "high-resistance lamp.

5731 "92 x-Q. Exclusive of the Edison Company, do "you know of any manufacturer of incandescent "lamps using vegetable or fibrous carbons of "any kind, who does not treat the carbons either "by internal or external deposition?

"A. I have never seen a commercial incandes- "cent lamp that I felt sure was not treated, judging "simply by its appearance. Such information is "very difficult to get.

"93 x-Q. Referring to the Sawyer-Man patent
5732 "211,262, is not the process there described a "process for building up the carbons by the exter- "nal deposition of deposited carbon upon the car- "bon pencils.

"A. Yes, such process is clearly indicated, but "I do not see that the patent confines itself to that "process.

"94 x-Q. Do you find anywhere in the patent a "description or direction of any method except

"the method of depositing carbon upon the ex- 5737
"terior surface together with the incidental filling "of the pores of the material necessarily incident "as a stage in the process of arriving at the depo- "sition of this exterior carbon?

"A. I find in the second paragraph of the "second column a fairly complete statement of "what the process is considered to be by the inven- "tors. The results of heating the carbon in a suit- "able hydro-carbon atmosphere are there stated
"to be the decomposition of the surrounding matter, 5738
"the carbon of which enters and fills up its pores "to an extent impossible except with matter in a "very attenuated state and deposits a perfectly "homogenous layer, generally of a bright gray "color, upon the exterior surface.' So far I "would say that the filling of the pores by the "decomposition of attenuated gas within the car- "bon is the important feature of the process, the "incidental deposition of carbon upon the surface
"being a necessary consequence of such treat- 5739
"ment. By the process as described up to this "point I believe the best results are obtained for "lamps of moderate candle-power for high electro- "motive force; but, if it is desired to produce a "thicker carbon, the size may be increased as fur- "ther described in the same paragraph by allow- "ing the external coating to become as thick as "desired. I would therefore say to complete my "answer to this question that I agree substantially
"with your statement of the case except that I 5740
"would reverse the relative importance of the ex- "ternal and internal treatment for the reasons "that I have indicated.

"95 x-Q. And you do that because your knowl- "edge at the present time informs you that in- "ternal deposition is useful and external deposi- "tion detrimental or injurious, is that so?

5741 "A. I think I have stated clearly in my answer
"to a previous question that for some purposes
"internal treatment is desirable, and for others
"external treatment may be equally so.

"96 x-Q. Does not the Sawyer-Man patent
"describe the continuous deposition of an external
"shell which may be made of such a thickness
"that carbon pencils may be cut from the material
"of the shell itself?

5742 "A. Yes, I believe the description of the pro-
"cess fully covers that method of producing car-
"bons also."

"114 x-Q. Of the lamps No. 1 to 10 presented
"or referred to by you on direct, you state that
"certain of them had paper carbons. Was this
"bristol-board carbon?

"A. Yes; they were all bristol board, I believe.

"115 x-Q. Who did the carbonizing of the
"various materials used by you in those experi-
5743 "ments?

"A. I did part of it myself up to the point of
"placing the crucibles in the furnace, and watch-
"ing the furnace and removing the carbons from
"it. Mr. Frank Smith did some of it, and after-
"wards some carbons were packed for carboniza-
"tion by the man who has that work regularly in
"charge. That was after he had seen us do it
"and knew what we wanted done.

"116 x-Q. How many hands are employed by
5744 "the Westinghouse Company?

"A. The last time I inquired I think there were
"about 800 on the pay-roll of the factory.

"117 x-Q. And your factory has a complete out-
"fit for most extensive manufacture in all me-
"chanical and electrical details of all machines
"and appliances incidental to a complete system
"of electric lighting, has it not?

"A. It is so considered, I believe. 5745

"118 x-Q. And you have general supervision
"over all the electrical work done by the company,
"have you not?

"A. Yes.

"119 x-Q. Of what department in the factory
"is Mr. Frank Smith in charge?

"A. He is now in charge of experimental lamp
"work.

"120 x-Q. How many hands are employed in 5746
"that department?

"A. That would be very difficult to say, as the
"number varies very greatly from one time to
"another according to the needs of the work; but
"there are always about a dozen people engaged
"in such work."

"129 x-Q. You stated something in your direct
"examination as to the use of nitrogen gas. Do
"you know of any commercial lamps to-day in
"which nitrogen gas at or near atmospheric pres- 5747
"sure is used.

"A. No.

"130 x-Q. Do you know of any commercial
"lamps to-day which have an attenuated atmos-
"phere of nitrogen gas?

"A. Well that depends a little on the view taken
"of the question. The intention is, I believe, to
"remove as far as possible all traces of nitrogen,
"oxygen, and other gases of the atmosphere. All
"lamps, however, contain a highly attenuated at- 5748
"mosphere of these gases, since it is utterly im-
"possible to remove it.

"131 x-Q. In other words, you do not know of
"any lamps having attenuated atmosphere of
"nitrogen gas except as such gas is present neces-
"sarily in an attenuated atmosphere of air?

"A. I do not know of lamps of any other sort,

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"although I believe a certain German lamp, whose
"name I have forgotten, contains some such gas.

"132 x-Q. You stated in answer to question 21,
"that you have made successful lamps contain-
"ing an atmosphere of nitrogen. To what extent
"were those lamps exhausted?

"A. They were exhausted to pressures varying
"from a little over half an inch to about an eighth
"of an inch mercury. I have filled lamps at about
5750 "atmospheric pressure also; but they were not
"the ones referred to in that answer."

"Adjourned to meet at 2 P. M.

"133 x-Q. Are not the incandescent lamps
"universally adopted at the present day, lamps in
"which an atmosphere of air is exhausted to the
"highest possible degree of tenuity?

"A. I believe so.

"134 x-Q. Do you know of any commercial lamp
"which is, or for some years has been, in use, in
5751 "which the glass globe is composed of two separ-
"able pieces, as distinguished from a glass globe
"the parts of which are fused together so as to be-
"come a continuous mass?

"A. No, I do not.

"135 x-Q. Have you any knowledge of the
"stopper lamps, consisting of a glass globe and
"separable glass stopper ground to fit the same,
"which were at one time put on the market by
"the American Electric Light Co. of New York
5752 "City?

"A. I have not.

"136 x-Q. Turning to the Sawyer-Man lamps
"presented by you, please make a sketch showing
"definitely the construction of the stop-cock in
"the base of those lamps?

"A. In answer to your question, I would per-
"fer to offer in evidence a lamp that was broken,

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"and which shows the condition of the lower part
"of the lamp before it is exhausted. The attach-
"ed lead tubes are the same as were used in our
"work for the purpose of filling and exhausting.
"The valves in this lamp are the same as were
"used in all of the lamps of this form made by us.

"137 x-Q. What is the size of the aperture in
"the bottom tube? Is it uniform with the apert-
"ure shown at the end of the tube just above the
"glass plate? 5754

"A. Yes, it is of that diameter throughout its
"length.

"138. x-Q. And the stopper is of very much
"larger diameter than the tubular aperture
"through which the nitrogen flows?

"A. Yes, it is.

"139 x-Q. And the stop-cock is made cone-
"shaped, being less in diameter at one end than at
"the other, is it not?

"A. Yes. 5755

"140 x-Q. Look at the drawings of the patent
"in suit and state how the size of the gas tube in
"your lamps compares with the size of the gas
"tubes shown in the drawings in the patent?

"A. That in the drawing in the patent is larger,
"I think, than the one used in our lamps.

"141 x-Q. The gas tube in figure 5 is about
"twice the diameter, even in that reduced figure,
"of the gas tubes in your lamps, is it not?

"A. Yes, it is. 5756

"142 x-Q. And the glass globes, or bells, in your
"lamps, are of the same diameter as shown in
"figures 3 and 4 of the patent?

"A. It is substantially.

"143 x-Q. If figure 5 were drawn on the same
"scale as figure 3 and 4, what would be the differ-
"ence in diameter between the gas tubes of the

5757 "size shown in the patent and the gas tubes used "in your lamps?

"A. The diameter of the tube in the drawing "would then be about three times the diameter "of the tube used by us.

"146 x-Q. And how does the diameter of the stop-"cock used by you compare with the diameter of "the screw used to close the gas tube in the draw-"ings of the patent?

5758 "A. It is between two and three times the diam-"eter, and would, if the drawing were full size, "be, I suppose, one and a half to two times the "diameter.

"147 x-Q. So that, compared with the size of "the gas tubes, your stop-cock is about six times "as large as the relative sizes of the stop-screw "and gas tube of the drawings of the patent in "suit?

"A. Yes.

5759 "148 x-Q. The stop-screws in the drawing of "the patent in suit are substantially of the same "diameter as the gas tubes which they close, is "that not so?

"A. Yes, I believe so.

"149 x-Q. Whereas, the diameter of your stop-"cocks is at least six times the diameter of the "tubes that they close?

"A. Yes.

"150 x-Q. And to the bottom of the gas tubes
5760 "you fused lead tubes leading to the connections "with the air pump or nitrogen apparatus?

"A. Yes.

"151 x-Q. And when the lamp was either ex-"hausted or charged with nitrogen, did you insert "the stop-cocks while the lamp was still under "pumps or bags?

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"A. The stop-cocks were always in place. They "were turned when it was desired to close off "communication with the lamp. This was done "while the lamps were still connected to the "pumps or bags.

"152 x-Q. Did you then seal off the lead tube "by fusing?

"A. No; we found the valves were tight enough "to hold without this.

"153 x-Q. How did you grind the stop-cocks to 5762
"fit into the tapered cone which received them?

"A. They were ground in the ordinary way by "coating the surface with rouge, or some other "suitable substance as was dictated to the work-"man by his experience in such matters. I saw "the work being done at the time, but gave no "special instruction, except that I wanted a valve "which would be certainly air-tight.

"154 x-Q. And your direction to the workman
"was to make a valve or air-cock which should be 5763
"perfectly air-tight?

"A. The instruction was hardly so general as "that. I limited the form of the valve to an or-"dinary cone valve such as is fitted to gas bags.

"155 x-Q. Would the small screw shown in the "patent, figure 5, be an efficient stop to insure a "vacuum in the lamp?

"A. I think it could be made so; but it is not "a form usually employed for that purpose, nor
"was it, I believe, at the time the drawing was 5764
"made.

"156 x-Q. But if the screw shown in the patent "was as a matter of fact used to prevent the egress "of nitrogen substantially at atmospheric pres-"sure, it might be sufficient, might it not, until "such time as the lamp was further sealed?

"A. Yes; I think it would also hold nitrogen,

5765 "and much more readily than it would preserve
"a vacuum.

"157 x-Q. Having regard to its size and pro-
"portion in relation to the gas tube which it
"closes, it is not a form of stop which you would
"ever think of using as a means of retaining a
"high vacuum in a lamp, is it?

"A. Yes; I would undertake to maintain a va-
"cuum with a valve of that kind long enough to
5766 "complete the seal; but I do not think it would
"be nearly so good as the cone valve. There
"would be much greater chance of failure.

"158 x-Q. Turning to the upper part of the
"lamp, I notice in your direct testimony that you
"described the U-shaped clamp or holder within
"the larger clamp as a platinum clamp or a bent
"piece of platinum. By what means do you ar-
"rive at the conclusion that that bent piece was
5767 "platinum?

"A. I saw it in the Patent Office model.

"159 x-Q. Do you understand that this clamping
"piece shown in the drawing of the patent is any-
"thing different from the clamping piece which
"you say forms a part of the lamp sent to the
"Patent Office as a model lamp of the patent in
"suit?

"A. The only difference that I know of is that
"the drawing shows a much thicker piece than the
5768 "pieces of platinum used in the Patent Office
"model. The purpose is evidently substantially
"the same.

"160 x-Q. What material are the large clamps
"in Patent Office model?

"A. They are made of carbon.

"161 x-Q. As I understand you, in only two of
"the lamps made by you did you make use of
"these small pieces of platinum?

"A. Yes; that is correct.

"162 x-Q. How many additional surfaces of con- 5769
"tact at the clamps is caused by the presence of
"these platinum clips?

"A. The number is doubled, I should say.

"163 x-Q. That is to say by the use of the
"platinum clips there results twice the number of
"surfaces between which efficient electrical con-
"tact has to be made at the clamps as compared
"with the omission of the platinum clips?

"A. Yes. 5770

"164 x-Q. What is the law governing the pro-
"duction of heat at points of contact, such as
"points of contact between the carbon arch and
"the clamp, first as regards the resistance of con-
"tact, and secondly, as regards the force or in-
"tensity of the current.

"A. The general law would be that the produc-
"tion of heat varies directly as the resistance and
"directly as the square of the current where the
"resistance remains unchanged, leaving out all 5771
"other considerations.

"165 x-Q. That is to say, taking two identical
"Sawyer-Man lamps which vary only as the re-
"sistance at the clamps, the amount of heat de-
"veloped at the clamps in one lamp as compared
"with that developed in the other would vary
"directly with the resistance of those clamps?

"A. Yes, with the same current.

"166 x-Q. Is it not also true that the heating
"effect upon any body by a radiant source of heat 5772
"in air or vacuo diminishes as the square of the
"distance between the source of heat and the body
"to be heated?

"A. Yes.

"167 x-Q. So that a radiant source of heat at
"twice the distance has only one-quarter the ef-
"fect it would have at unit distance?

5773 "A. Yes.

"168 x-Q. In all commercial lamps of the present day intended for use in multiple arc, as is "Complainant's Exhibit Defendant's Lamp, is it "not true that the carbons used are of great "length compared with their diameter, so that "they assume the filamentary character?

"A. Yes.

"169 x-Q. In lamps intended for such use, what
5774 "is the advantage in such great length and small "cross-section?

"A. The great length and small cross-section "are attributable directly to the specific resistance of the carbon. It so happens that the specific resistance of carbon is such that for a lamp "intended to operate on a circuit of about 100 "volts, the conductor of carbon must be quite "long in proportion to its diameter. Had it so "happened that the specific resistance of the car-
5775 "bon was one-tenth, say, of what it really is, "a much longer and much thinner carbon would "have been required. And if it had been ten "times the actual resistance, a hundred volt car- "bon would be moderately short and thick. I "would therefore say, that great length and thin- "ness are not so much an advantage of lamps in- "tended for use in multiple arc as a necessary "consequence of the conditions of the material of "which they are made.

5776 "170 x-Q. Again I ask you what are the advan- "tages, as a matter of fact, to the lamp itself by "using a carbon of great length as compared with "its diameter, when using lamps in multiple arc?

"A. The advantage consists in the fact that a "sufficiently high electro-motive force may be "used to render possible the distribution of cur- "rent without too great cost in conductors.

"171 x-Q. Assuming the diameter of the car- 5777
"bon to remain the same, what would be the dif- "ference of heating effects produced at the clamps "in the Sawyer and Man lamps by using in one case "a carbon burner twelve times as long as in the "other, the lamp in both instances being raised to "the same candle power?

"A. The long carbon having twelve times as "great a surface would require a much lower tem- "perature to produce the same total amount of "light; that is, the light-giving power would be 5778
"spread out, as it were, over a larger surface. In "order to do this a much smaller current would "be required in the long carbon than in the short "one, while a higher electro-motive force would "be required. The total energy required to give "the same amount of light would be much greater; "that is, the lamp would be less efficient; but the "loss at the contacts themselves would be smaller "owing to the reduced current.

"172 x-Q. Now assuming the other conditions 5779
"the same, what would be the effect upon the heat "produced at the clamps by diminishing the "cross-section of the carbon burner so as to give "the same illumination in both instances, the "same illumination per unit surface?

"A. That would still further reduce the heating "at the clamps, provided the conditions at the "contact were the same in each case; that is, "assuming that the surfaces in contact remained "the same. Since, however, the reduction in the 5780
"cross-section of the carbon is usually accom- "panied by a reduction of the surfaces in con- "tact, the comparison cannot be made in any such "off-hand way as this. There is, however, no dif- "ficulty in so proportioning the contacts as to "make a perfectly practicable lamp in either "case.

5781 "173 x-Q. Is it not a fact that experiments and "practical use have shown that there is a degree "of incandescence beyond which for the same "material it is not profitable to go, and which, if "exceeded, materially militates against the life of "the lamp?

"Yes.

"174 x-Q. And is it not a fact that in manufac-"turing high candle-power lamps, very long car-
5782 "bons are adopted for use?

"A. Yes, carbons of great length are sometimes "used, and sometimes carbons of very short "length.

"175 x-Q. In multiple-arc lamps, are not the "carbons of high candle-power always used of "great length?

"A. Yes, I presume they would be so called as "ordinarily used.

"176 x-Q. With which carbon will you have
5783 "the least heating of the clamps by radiation, in "a short carbon or in a long carbon of a loop "form?

"A. That depends so much on the exact con-"struction of a lamp that it cannot be definitely "answered in so many words. There is no difficulty, "however, in making the clamps or contacts of either "form such that the radiation would be so small "as to not seriously affect the commercial value of "the lamp. I think, as a matter of fact, however,
5784 "taking commercial lamps as they go, that there "is more loss from this source in very short-car-"bon lamps, like the Bernstein, for instance, (see "Exhibit Bernstein Lamp) than in long-carbon "lamps like the Edison lamp, both of which are "commercially successful lamps, I understand.

"177 x-Q. The Bernstein is a series lamp, is it "not, and not a multiple-arc lamp?

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"A. Yes it is used in series exclusively, I think.

"178 x-Q. When was the Bernstein lamp in-"troduced?

"A. I don't know, more than five years ago, I "think.

"179-Q. Taking a carbon burner or conductor "of considerable diameter, have you not noticed "that the electric current will take the shortest "path or the path of least resistance from one "clamp or holder to the other through that carbon? 5786

"A. More current will pass along the side of "least resistance certainly.

"180 x-Q. And if in any conductor there is a line "of less resistance, more current will pass through "this line of less resistance inversely as the re-"sistance?

"A. The current will divide itself inversely as "the resistance; I believe that is what you intend.

"181 x-Q. And this variation of the current in "different parts of the carbon conductor will ren- 5787 "der the conductor hotter at places of least resist-"ance, the heat depending upon the current pass-"ing through that part of the conductor?

"A. That depends altogether on how the parts "of high resistance are located with reference to "the parts of low resistance; but if they are in "parallel throughout, and not in series, the state-"ment is correct. If they were in series, the re-"verse would be the case.

"182 x-Q. And in so far as this difference of 5788 "heating exists in the carbon conductor it has a "tendency to dissociate the particles of carbon "and shorten the life of the carbon as an incan-"descent?

"A. That is so theoretically, at least in every "lamp of the horseshoe-carbon type; but it requires "very abnormal conditions, indeed, to develop it "to a noticeable extent.

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"183 x-Q. The larger and thicker the horseshoe "carbon the greater the liability to this effect?

"A. The shorter and thicker radially—yes.

"184 x-Q. So that in this respect a long fine "filamentary carbon has an advantage over a short "thick carbon.

"A. Such may be the case, yes, if the shorten- "ing and thickening are carried far enough.

"185-Q. Look at the Packard Exhibit No. 6,
5790 "and say whether the condition of the carbon in "that lamp does not indicate to you that the in- "tensity of the current has been greater on the "inner circumference than on the outer?

"A. It looks as if that might have been the case "and I know it was the case in one of the lamps "I saw running at the 23d street factory. The "difference in color between the outer edge and "the inner edge was just noticeable when the lamp "was burning.

5791 "186 x-Q. And the greater the difference be- "tween the length of the inner circumference and "the outer circumference, the greater the propor- "tion of current which will pass along the shorter "inner circumference?

"A. Yes, it would not do to make this differ- "ence too great for that reason. It would not, at "least, make as good a lamp.

"187 x-Q. And in long, thin carbons, such as "used in the complainant's exhibit, defendant's
5792 "lamp, this difference of length between the inner "and outer circumference is reduced to an almost "inappreciable amount, is it not?

"A. Yes, and even in a carbon like that the "Bernstein lamp contains.

"188 x-Q. And the shorter the arch or circle "the greater this difference between the length of "the inner and outer circumference?

"A. For the same width, yes.

5793

"189 x-Q. So that a short, thick, arch-shaped "carbon would have this difference to a very "much greater degree than a long slender carbon?

"A. Yes, that is true; but unless the carbon is "made very short or very thick radially, or both, "the difference would not be great enough to "amount to anything sufficient to affect the com- "mercial use of the lamp.

"190 x-Q. What percentage of variation be- "tween the outer and inner circumference is, from 5794 "your actual experience, allowable?

"A. I never noticed in my own experience any "lamp which showed that tendency, except the "one last referred to, and forming Packard Ex- "hibit No. 6, although I have seen some very "short arch carbons in use. I think the propor- "tions in the Packard Exhibit No. 6, are about "the limit in that direction, if the best result is "aimed at. No doubt, however, a workable "carbon could be so made, with even a greater 5795 "difference than this.

"119 x-Q. But your supposition that a worka- "ble lamp could be so made is not based on actual "experience, but is simply an expression of your "present opinion, which might be modified by "experience, is that so.

"A. Yes.

"192 x-Q. And as a matter of fact, you have "not tested the carbon arch in which the propor- "tional difference between the outer and inner 5796 "circumference was greater than the Packard "Exhibit No. 6?

"A. In my opinion, the carbon in Pittsburgh "Exhibit No. 1 shows even a greater difference "between the outer and inner edge of the carbon, "or certainly as great, and I am quite positive "that in the case of Pittsburgh Exhibit No. 1 the

5797 "peculiarity in respect to difference of tempera-
"ture was not noticeable while the lamp was in
"operation, or I should have detected it.

"193 x-Q. What experiments did you make at "Pittsburgh with your Sawyer-Man lamp to determine the electro-motive force or difference of "potential in each lamp?

"A. They were measured in the ordinary way in "the photometer room, at various candle-powers
5798 "or degrees of incandescence.

"194 x-Q. What was this electro-motive force, "as ascertained by your experiments?

"A. It varied with each lamp, and was from 12 "or 15 volts to about 30, the average being about "20 volts, I should say.

"195 x-Q. Do I understand that you measured "the electro-motive force for the same lamp at "different candle-powers?

"A. Yes, we did that; but what I wanted to
5799 "say was, that the different lamps were run at different electro-motive force.

"196 x-Q. What would be the effect of placing "one of your Sawyer-Man lamps in a multiple arc "system, such as is used for the complainant's exhibit, defendant's lamp?

"A. There is no lamp among the exhibits suitable for as high an electro-motive force as that "of the lamp referred to. If placed on the same "circuit the Sawyer-Man lamp would require some
5800 "additional resistance placed in series with it.

"197 x-Q. As a matter of fact, any of your Sawyer-Man lamps would be very rapidly destroyed "if placed in a multiple-arc system such as used "with the Edison lamp I referred to?

"A. Yes, it would, if placed in such circuit "without any resistance or other means of reducing its current to the proper amount.

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"198 x-Q. That is to say, that with the same "amount of current passing through the lamp in "multiple-arc, your Sawyer-Man lamps would very "soon be destroyed?

"A. The lamp would be destroyed owing to the "fact that it would take a much greater amount "of current from a circuit of a pressure sufficiently high to run a 100 volt lamp than it would be "able to carry, owing to its low resistance. The "current would not, however, be the same in the
"two lamps as your question would indicate, but 5802
"the lamps would rather be subjected to the same "electrical pressure.

"199 x-Q. And the lower the resistance of the "lamp the greater its unsuitability for use in multiple arc in a circuit of higher electro-motive "force?

"A. Yes; assuming that lamps of the same "candle power are taken.

"200 x-Q. And if, as you say, you should in-
"troduce sufficient resistance to lower the differ- 5803
"ence of potential in the lamps to an amount "suitable for your Sawyer-Man lamp or other "lamps of low resistance, you would by the fact "of the introduction of such resistance, be wasting just so much electro-motive force considered "as a source or means of incandescence?

"A. Yes.

"201 x-Q. Is it, therefore, not true that in all "practical purposes your Sawyer-Man lamp, or
"lamps of similar or lowered resistance are not 5804
"practically adapted to be used in a multiple-arc "system?

"A. That would be assuming that the electro-motive force now used by the Edison Company "is as low as could be practically so used for any "commercial purpose. I do not believe that this "is the case.

5805
"202 x-Q. Returning to the patent in suit, have "you measured, or will you measure, the difference in the radius, and, consequently, in difference of length of inner and outer circumference "of the carbons shown in figures 3 and 4?

"A. Subject to correction on more accurate "measurement, I should say that the outer circumference is about one-third greater than the "inner circumference.

5806 "203 x-Q. Which is the easier mechanical job, "the attachment of the radiators or conductors "to the upper base plate, as shown in the figure "2 of the patent, or as shown in the figure as "presented you?

"A. I would say that there is very little difference, except in case the workman did not have "a suitable small wrench, in which case he could "more easily tighten up the nuts as they are located "in the exhibits, than where they are inside be-
5807 "tween the radiators, as shown in the drawing. "I regard the difference as utterly insignificant.

"204 x-Q. He would require a special wrench "or tool to get at the nuts when situated as shown "in the patent?

"A. I believe workmen of the kind employed "on this sort of work usually have among their "kit of tools a wrench suitable for this purpose. "It would simply be a small narrow wrench of ordinary form, and of a proper size to fit the nut
5808 "shown.

"205 x-Q. And suppose you gave the job of "attaching the radiator to the upper base plate "to a workman used to this kind of work, without "directing as to where he was to put the nuts, "would he not naturally use the easier method "adopted by you or your workmen in your exhibits?

5809
"A. Yes; I should say he might very likely do "so, although I have been quite often astonished "at the inconvenient places in which instrument "makers will locate screws without any apparent "reason.

"206 x-Q. As a matter of fact, the resistance "in a circular carbon arc diminishes as the diameter of the arch diminishes, does it not?

"A. Yes, other things being equal.

"207 x-Q. And if the aim and object was to 5810
"get a carbon of low resistance, it would be preferable for that purpose to use a circular carbon "of small diameter?

"A. Diameter of the arc, yes. Small diameter "of the arc itself would increase the resistance.

"208 x-Q. And so far as a circular carbon was "of increased diameter, other things remaining "the same, the effect of this increased diameter "would be proportionately to prevent the attain-
"ment of a carbon of low resistance? 5811

"A. If you still mean by increase of diameter "increase in length of the carbon, that is correct.

"209 x-Q. And if the object of Messrs. Sawyer "and Man in constructing the lamp shown in the "patent was to produce a lamp of low resistance, "was it not the natural means of producing such "low resistance to approximate the terminals "holding the carbon clamp and so lessen the "length of the arc of carbon?

"A. Yes, that would be a natural way of ac- 5812
"complishing that result, but it might have been "used for other purposes also, and for reasons entirely outside of the resistance of the carbon.

"210 x-Q. But the construction shown in the "patent in suit agrees with the construction naturally adapted for a low resistance carbon, that "is, a carbon of short length?

"A. It was adapted for a carbon of short length

5813 "and low resistance such as that shown in the "drawing, and also for a carbon of greater length "and comparatively high resistance, as, for ex- "ample, those in Exhibits No. 5 and 6 presented by "me, and for still longer and still thinner carbon.

"211 x-Q. The carbon shown in the patent in "suit, if of the length shown in figures 3 and 4, "and of the thickness shown in figure 4, would "have a very low resistance, would it not?

5814 "A. Yes, very low for a lamp carbon.

"213 x-Q. And the distance between the termi- "nals as shown in the patent, agrees with the me- "chanical construction which would be intelli- "gently adopted for the use of the short and "thick carbon of low resistance?

"A. Yes, it does.

"213 x-Q. What, in your opinion, would be the "comparative resistance of the carbon shown in "your exhibits 4 and 5, as compared with the car-

5815 "bon of the dimensions shown in the patent in "suit?

"A. Roughly speaking the resistance of the "lamps you have referred to, would be at least "twenty or thirty times as great, I should say.

"214 x-Q. What, roughly, would be your esti- "mate of the resistance of the lamp if constructed "as shown in figures 3 and 4 of the patent?

"A. I should not expect it to be more than an "ohm or so, possibly two or three.

"215 x-Q. That includes the entire lamp resist-

5816 "ance, contacts and connections?

"A. Yes, it was intended to include the entire "circuit within the lamp as the question indicates.

"216 x-Q. And what would be the resistance of "the carbon if constructed as shown in figures 3 "and 4 of patent, and treated in the same manner "that you treated your exhibits?

5817

"A. I should not suppose it would be so great "as one ohm, and not very much less. In my "former answer I placed two or three ohms as an "outside estimate which I thought it would not "possibly exceed.

"217 x-Q. Take your Exhibit lamp No. 1, what "is the resistance of the carbon in that lamp?

"A. About nine ohms, measured cold, four and "a half, hot.

"218 x-Q. Compare the size of carbon in your 5818 "lamp, figure 1, with the size of the carbon shown "in figures 3 and 4 of the patent in suit.

"A. The drawing seems to show a carbon about "one-third as long, about six or eight times as "thick and approximately the same width as the "dimensions of the carbon in my Exhibit No. 1. "This would make the resistance from eighteen to "twenty-four times as great in Exhibit No. 1 lamp "as in the drawing.

"219 x-Q. Are not the other exhibits as pre- 5819 "sented by you of a very much higher resistance "than your Exhibit No. 1.

"A. Yes, Exhibit No. 4 contains a silk carbon "intended to be of moderately high resistance, "considerable length and thinness, for the pur- "pose of ascertaining the ability of such carbon "to live in a lamp of the original Sawyer-Man "construction.

"220 x-Q. Assuming lamps of the same candle- "power and efficiency, is it not true that the longer 5820 "the carbon is made, the smaller the curent re- "quired to operate it?

"A. In a general way that is true.

"221 x-Q. With such lamps having carbons of "similar sections, does not the sectional area in- "crease as the squares of the side dimensions of "the said section?

5821 "A. Yes.

"222 x-Q. Does not the current required in-"crease nearly as the sectional area increases, under "the same assumption as to lamp construction as "in the last two questions?

"A. No. It is more nearly proportional to the "diameter.

"223 x-Q. Take two carbons otherwise identical, "one having twice the sectional area of the other "would it not take twice the curret, under the
5822 "previous assumptions, to heat this larger carbon "to the same temperature?

"A. Not at all.

"224 x-Q. Is your answer applicable to all forms "of cross-section, and if not to what shapes of "cross-section do you consider it applies?

"A. It applies to all the usual shapes of cross-"section employed in commercial lamps, and "would be least applicable to a carbon of the form "of a very thin ribbon.

5823 "225 x-Q. Would your answer apply to exhibit "lamp No. 1, if you doubled the area of your car-"bon by doubling its width?

"A. Only in a slight degree. The current "would in that case be more nearly proportional "to the cross-section. The reverse would be the "case, if the thickness were doubled, in which "case the increase in current required to bring "the lamp to incandescence would be much less "than double the amount previously required.

5824 "226 x-Q. In the carbon shown in Figs. 3 and 4 "of the patent if we double the section area, "keeping the sections similar, how much do you "think the current would have to be increased to "raise it to the same temperature?

"A. I don't know.

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"227 x-Q. Would it not have to be more than "double?

"A. I cannot see that it would. I should say, "certainly, less than double.

"228 x-Q. Assuming the carbon to be clamped "as shown in the figures of the patent, the clamp "always embracing the same length of the carbon, "does not the surface of contact in the carbons at "the clamp increase directly as the side dimen-"sions of the carbon? 5826

"A. Yes, that would be the case, if I understand "the question.

"229 x-Q. Does not the resistance of the con-"tact vary inversely as the surface of the contact, "that is to say inversely as the side dimensions of "the carbon, all other conditions remaining the "same?

"A. Yes.

"230 x-Q. Does not the current passing over "this resistance vary more rapidly than the sur- 5827 "face contact, assuming carbons of similar cross-"section, and the same temperature in clamps "like the drawing of the patent?

"A. Not necessarily; but I think that in most "cases that would be so?

"231 x-Q. In two such lamps would not the "heat produced at the clamp contact be greater "in the carbon of large section than in the other?

"A. It very likely would, but I must add in "connection with this and my previous answers 5828 "that I consider all these limitations as to con-"tacts of the same length, and clamps of the same "size and form purely hypothetical, and such con-"ditions as would never be contended with in the "actual production of a lamp. It is a matter "involving only ordinary common sense, "to make the contact large enough and good "enough for each size of carbon, and I would

5829 "call attention to the fact also, that a strong thick "carbon can be squeezed up very tight in the "clamps, thus securing a good contact, while with "a small, fragile carbon, great care is required in "mounting, and the contact is apt to be loose. "This whole question, and the answers I have "given to the questions on the same subject pre- "ceding, is purely a matter of experience, and "the mounting of carbons of any size, even from
5830 "that indicated in figures 4 and 5, as some pat- "ent office draughtman's idea of how large a car- "bon ought to be, down to the smallest filament "used in the highest resistance lamp of modern "manufacture, presents no difficulty whatever.

"232 x-Q. Will not the heating of the clamps "by conduction, also be greater in the carbon of "large section?

"A. Yes. I have in previous answers fully "explained this matter as I understand it.

5831 "233 x-Q. Similarly, will not the heating of the "clamps by radiation from the carbon of the "shape shown in the Letters Patent be greater "than in the longer carbon than there shown?

"A. Yes, most certainly this will be the case.

"234 x-Q. Will not the insertion of the platinum "foil as shown, increase the heat produced at the "clamps by the current?

"A. No, it reduces the amount of heat for
5832 "several reasons. In the first place a contact at "the same pressure between the platinum and "carbon offers less resistance than a contact be- "tween two pieces of carbon. In the second "place, the pressure can be made greater by the "use of platinum, owing to its softness. It is un- "necessary to state any others I believe.

"235 x-Q. At what candle-power did you test "lamp No. 1?

"A. At ten candle power.

5833

"236 x-Q. At what candle-power was it run?

"A. I meant by my previous answer that it "was run at ten candle power. It was tested "at seven and eleven also.

"237 x-Q. At what candle-power did you test "and run lamp No. 7?

"A. At one and five-tenths candle-power, ex- "cept one day, when it was run very much higher "than this. I suppose at more than twenty can- "dle power. 5834

"238 x-Q. At what candle-power did you test "and run lamp No. 8?

"A. It was run at 20 candle power.

"239 x-Q. What were the volts, amperes and "watts of lamp No. 1?

"A. 14.5 volts, 7.3 amperes, 105.8 watts; 10.58 "watts per candle-power.

"240 x-Q. You state that your experiments with "treating blotting paper showed a very large re- "duction of resistance due to the process of 5835 "treating. Was not this due to the porosity "of the blotting paper?

"A. Yes, in a large measure.

"241 x-Q. If it were not for that treatment, "would not blotting paper, in your opinion, be "eminently disqualified for use in an incandescent "lamp?

"A. Without treating or something to take its "place I do not think it would be useful; but it 5836 "makes a remarkably good carbon for lamps of "low resistance when properly treated.

"242 x-Q. But if used untreated and carbonized "without treatment, its life would probably be "very short, would it not?

"A. That would be a mere guess on my part, as "I never tried it in that way.

5837 "243 x-Q. All your electrical knowledge and "experience as to incandescent carbons would "lead you to assume that such would be the case, "would they not?

"A. I should think that probable.

"244 x-Q. Have you had any experience in "treating carbons in hydro-carbon oils or liquids, "or such substances as melted bees-wax, olive oil, "etc.?

5838 "A. No, I have had no personal experience in "treating carbons by direct immersion in a hydro- "carbon of liquid form. All such treating with "which I have had anything to do has been from "the vapor arising from hydro-carbon liquids.

"245 x-Q. Do you, or do you not know, that "when carbon is treated in hydro-carbon liquid "by immersion, nearly all deposit is an external "shell, the cooling effect of the liquid causing an "almost instantaneous deposit upon the external
5839 "surface of the carbon, so preventing any further "internal deposit?

"A. That might be the case, I should think, "but I do not feel prepared to say that it would "under all conditions.

"246 x-Q. The more porous the carbon the "greater the variation that can be produced by "treatment according to your methods, is that not "so?

"A. I have previously answered that question "about as follows: The more porous and the
5840 "greater the susceptibility to the tempering pro- "cess and consequent consolidation of the fibres, "the greater will be the reduction in resistance. "The reduction of resistance is produced, gener- "ally, I think, by this consolidation and internal "deposition of carbon.

"247 x-Q. I believe you stated that in the

"vacuum lamps among your exhibits, you brought "the carbons to incandescence in vacuo for the "purpose of removing the occluded gases. Are "you, or are you not, aware that that process is "described in and covered by the specification and "claims of letters patent of the United States to "Thomas A. Edison, dated October 10th, 1882, "and No. 265,777? 5841

"A. I believe after its invention by Sawyer and "Man that process was patented by Mr. Edison.

"248 x-Q. I referred to the process of removing 5842 "occluded gases in vacuo. Do you understand "that that process of removing occluded gases in "vacuo was so patented to Mr. Edison?

"A. I have been told that a patent was issued "to him. I am not familiar with the patent. The "process of driving out occluded gases is described "in the patent in suit, whether in vacuo or in "nitrogen I believe to be immaterial.

"249 x-Q. You stated that it is, or was, known "that without the treating process the availability 5843 "of carbon as a material for conductors in incan- "descent lamps is certainly very limited. How "many materials do you know from your personal "experience to be available for that purpose "without treatment?

"A. I think all substances of a fibrous nature "are more or less improved by treating, and it is "simply a question of degree and the amount of "perfection aimed at in the production of the "lamp, and the consideration of cost of produc- 5844 "tion, that would set apart any definite number "of substances as belonging to the class con- "sidered suitable without treatment. I believe a "number of substances could be so used with con- "siderable success, as, for instance, paper, bam- "boo, several of the grasses, like Mexican grass,

5845

“ and perhaps a few others. I have had personal
“ experience with these materials in an untreated
“ state, and examined their behavior when sub-
“ mitted to an electric current.
“ 250 x-Q. When Prof. Stillman was at the
“ Pittsburgh factory what was the reason that he
“ only filled one lamp ?
“ A. He was delayed by the accidental breaking
5846 “ of the sodium retort.
“ 251 x-Q. Was that sodium retort all right the
“ day before he came ?
“ A. It was all right on the same day that he
“ came, and had been in use the day before.
“ 252 x-Q. You had no reason to think it was
“ going to break, just as he wanted to fill the lamp,
“ had you ?
“ A. No.
“ 253 x-Q. In the various fibres used in your
5847 “ commercial lamp globes presented by you during
“ your testimony by what method were the car-
“ bons treated ?
“ A. They were treated in the same way as I
“ have already described in connection with the
“ preparation of carbon for the six Sawyer-Man
“ lamps I have produced.
“ 254 x-Q. Exclusive of these experiments,
“ have you had any experiment with lamps of the
“ Sawyer-Man construction ?
5848 “ A. None whatever, if you refer to the old type
“ such as the exhibits.
“ 255 x-Q. How long were you working on the
“ silk carbon lamps before they were made a prac-
“ tical success ?
“ A. They were used commercially, from about
“ the time I became associated with the Switch &
“ Signal Co. It has always been the aim of Mr.
“ Westinghouse however to improve everything

5849

“ about the concern as much as possible, no mat-
“ ter how good it might be at any given time.
“ 256 x-Q. How soon after the lamps were
“ filled was the incandescence begun ?
“ A. As soon as the appearance of the sodium
“ indicated that the atmosphere in the lamps was
“ pure. This time would vary according to the
“ speed with which the operation was carried on.
“ Sometimes we did it very slowly and interrupt-
“ edly, and sometimes they were finished up with- 5850
“ in a short time, say, two or three hours.
“ 257 x-Q. About how long would you allow
“ the nitrogen to flow through the lamp, before
“ sealing off ?
“ A. For perhaps an hour or two.
“ 258 x-Q. And how long would the lamps be
“ treated to remove occluded gas, before being
“ sealed off ?
“ A. That was what I meant to say in the last 5851
“ answer ; I meant after the current was passed
“ through the carbon.
“ 259 x-Q. How long did it take to charge the
“ lamp with nitrogen gas by the Stillman ap-
“ paratus.
“ A. As we had it arranged I should say that
“ the amount of time continuously employed in
“ charging a lamp would be about three hours,
“ and after that an hour or two, possibly, for
“ driving off occluded gases ; so that about half a
“ day would be required to complete the operation 5852
“ thoroughly. This time might be very much
“ shortened, I suppose.
“ 260 x-Q. All your estimates of cost and com-
“ mercial expense of operation as to the Sawyer-
“ Man lamps are based upon these experiments,
“ as to which you have testified at Pittsburgh, are
“ they not ?

5853 "A. Yes.

"261 x-Q. How continuously were the lamps at "Pittsburgh, kept incandescent?

"A. Almost continuously after they were once "started. The current was interrupted, I sup-"pose, on an average of two or three times a "day. The lamps ran all night. Those tests "were carried on night and day at the Pittsburgh "factory.

5854 "262 x-Q. Was this in the same room as the "one in which the lamps were filled?

"A. No.

"263 x-Q. In bringing the lamps to New York how "many of them were broken in transit?

"A. Two.

"264 x-Q. Out of how many?

"A. Out of twelve. I will here state that the two "lamps broken were in a separate package and "were probably broken from some unusual and "severe shock.

5855 "265 x-Q. It has been stated that the Sawyer-"Man Company used bamboo carbons for the fila-"ments in their lamps. What portion of the "bamboo did they use?

"A. I am not personally and practically fa-"miliar with the manufacture of lamp carbons "from bamboo; but I have learned incidentally "that the outer and denser portion of the splint "next to the outer shell is preferable where the size
5856 "of the carbon will admit of its being limited to this "part, and I believe that is the part used at the "Sawyer-Man factory.

"266 x-Q. The lamps made by the Sawyer-Man "Company are all slender, or filament carbon "lamps, are they not?

"A. Not all, but nearly all."

130 x-Q. Continued by Counsel for Complainant:—

Did you give the testimony quoted by me, on cross- 5857
examination in the McKeesport case, and if so, are the facts therein stated by you true, and the opinions therein expressed still held by you?

A. I gave the testimony as quoted, and the facts are substantially as they are stated, I believe, and my opinions, as expressed, have not changed since that time.

131 x-Q. Is it not a fact that throughout this cross-
examination, which I have taken from the McKeesport 5858
case, the references to "the patent" and "the patent in suit" mean the Sawyer and Man Patent No. 317,676, unless it appears by the context that some other patent is intended?

A. Yes; I believe that is the fact.

132 x-Q. In answers 42 and 43 you refer to recent tests of the six Sawyer-Man lamps. Please explain those tests more fully, and how extensive they were?

A. The lamps were first tested by the use of the dis-
charge from the secondary coil of an induction coil of 5859
the Ruhmkorff type, to ascertain the color of the discharge through the space within the lamp. This method is used in the manufacture of commercial lamps to determine the degree of exhaustion, and it is found to be a reliable method. The lamps so tested, which included the six lamps referred to in my answer to question 43, gave indications of having maintained their vacuum or atmosphere of attenuated nitrogen, practically unchanged. In continuation of the tests, currents were
passed through the carbon of the same, or substantial- 5860
ly the same, amount as when they were originally tested in April, 1889, except in lamps Nos. 1 and 6 in which the carbons had been broken since that time. These tests were continued for a few minutes in each lamp, which was sufficient to indicate whether or not any air had leaked into the glass receivers. This test

5861

resulted in confirming the test by the induction coil, and was as conclusive as any test could have been unless sufficient time were allowed for a life test. The presence of air in the enclosing chamber would have very quickly shown an effect on the carbon, and even a very small leak would in the time that had elapsed since these lamps were previously tested have resulted in a deterioration of the atmosphere or vacuum within the lamp sufficient to have rapidly destroyed the car-
5862 bon.

133 x-Q. The test with the induction coil, as you made it, is only an approximate one, is it not?

A. It is only approximate so far as the actual quantity of gas contained in the receiver is concerned, but when used with proper experience in such work it is a means applied with great certainty in sorting out the bad lamps in commercial manufacture, and is relied upon entirely for this purpose in the work done in the Westinghouse lamp factory. This has been the case, I
5863 may say, as long as I have been connected with that company.

134 x-Q. Would your experience enable you to tell by this test whether a lamp of the character of these six lamps which had originally been provided with an atmosphere of nitrogen at or about atmospheric pressure, had received by leakage a small quantity of oxygen within the globe?

A. No, it would not.

135 x-Q. Did you in testing lamps Nos. 2, 3, 4 and
5864 5 with the current as stated in answer 43, take care to produce in the carbons the same degree of incandescence which you originally produced in the tests made prior to giving your dposition in the McKeesport case?

A. Yes, each lamp was connected in series with a Siemens. electro-dynamometer and the current adjusted by means of a resistance to that recorded in the

5865

original tests. In one or two cases the current was considerably higher than there shown owing to insufficient resistance.

136 x-Q. Have you a record of these recent tests showing the conditions and results which you are willing I should see?

A. I have a record and am willing to produce it.

137 x-Q. Does this record give sufficient data to make a comparison with the data as to the efficiency of these lamps which you gave in the McKeesport 5866
case?

A. No measurements were made on the photometer in the recent tests so that the efficiency in the usual understanding of that term, viz; number of watts per candle-power, was not redetermined; their practical efficiency as working lamps was shown not to have been impaired.

138 x-Q. In your answer to cross question 95 you speak of the 150-candle-power lamps as being made by mounting two carbons of 75-candle-power each in the 5867
same lamp globe. Is that the reason why you omitted the 150-candle-power lamps from the table of measurements given in answer 95?

A. Yes; I understood that question to be asked with reference to diameters of carbon and platinum wires used. The 75-candle-power carbon is the largest in commercial use by the Westinghouse Company.

139 x-Q. Then I understand that in these 150-candle-power lamps the carbons and platinum wires are of the same diameter as those in the 75-candle-power 5868
lamps set out in your table of measurements. Am I correct?

A. Yes.

140 x-Q. Do you make more than one voltage of these 150-candle-power lamps? If so, please explain the arrangement of the carbons and wires for each voltage.

A. Lamps of 150-candle-power are made from each

5869

of the two 75-candle-power carbons given in the table. The mounting is substantially the same in the two lamps; two carbons are connected to platinum wires in the usual way and sealed into the same bulb and connected in parallel in nearly all cases. For a lamp of 150 candle-power, 50 volts, two carbons like the last in the table with platinum wires as there specified, are mounted together, and for a similar lamp of 100 volts the carbons and wires given in the line next to
5870 the last are used in the same way. The table referred to is given in answer 95.

141 x-Q. Are these 150-candle-power lamps the same lamps referred to by you in answer to cross-questions 76 and 77.

A. Yes.

142 x-Q. What, if any, are the relations between the Westinghouse Company and the defendant in this case, with respect to the manufacture of the lamps referred to in your table of measurements?

5871 A. The lamps used by the defendant company are made with carbons manufactured by the Westinghouse Electric Company. These lamps are manufactured by the Sawyer-Man Company, of this city, at the present time.

143 x-Q. How about the lamps at present used and sold by the Westinghouse Company and by the Sawyer-Man Company and by the Consolidated Company?

A. The same answer would apply to these lamps also.

5872 144 x-Q. That is, the lamps used and sold by these several companies, including the defendant company, are the same lamps, and made in the same way and by the same manufacturing concerns?

A. Yes.

The further examination of this witness was adjourned to a time to be hereafter agreed upon.

5873

MARCH 6, 1890.

Met pursuant to adjournment.

Counsel present as before.

Re-direct examination of the witness O. B. SHALLENBERGER by Mr. CURTIS:

145 R-d Q. In your answer to 97 x-Q. you refer to certain improvements introduced into the art since 1880, relating to systems of distribution for the use of 5874
continuous currents. Have any improvements been introduced since the date referred to involving the use of currents other than continuous currents? If so, what are they?

A. Since the date referred to alternating currents have come into extensive use for central-station lighting by the employment of transformers or converters, from which the lamps are supplied with current. It was found that the use of such improvements as could be made in the apparatus for the distribution of direct 5875
currents, were still insufficient to render possible the use of currents of sufficiently high pressure for extended distribution in any practicable way, even when lamps having as high resistance as possible were used. By means of the alternating-current transformer, a high-tension primary current is caused to generate by induction low-tension currents at such points as it may be desired to operate lamps. The pressure or tension of the distributing circuit is, therefore, independent of, and unlimited by, the maximum pressure for which it 5876
is possible to construct the lamp; and the supply circuits to which the lamps are connected may be indefinitely subdivided, and placed at points more or less distant from each other. The system is in fact equivalent to the use of a large number of small generators which are in turn supplied with electrical energy from a common source. The two branches of the system, that is the distribution circuits and the supply circuits,

5877

thus become practically independent of each other, so far as the tension of the current is concerned.

146 R-d Q. Was this the system referred to in your answer to 108 x-Q, as rendering practicable at the present time in central-station lighting the use of lamps of less than 100 ohms resistance?

A. Yes. I had this system in mind when I made that answer.

5878 147 R-d Q. When was the transformer or converter system to which you have referred, introduced, and how extensively has it come into use since its introduction?

A. The first central-station plants on this system were installed during the latter part of 1886. Since that time a large number have been put in operation, whose combined capacity at the present time amounts to about 500,000 lamps of 16-candle power. The plants referred to are operated by alternating currents by the
5879 Westinghouse Electric Company in this country. A number of such plants are also in operation in different parts of Europe, as, for instance, at Rome, London and Milan.

148 R-d Q. Are any other companies beside the Westinghouse Company using the converter system in this country?

A. Yes. It is also in use by the Thomson-Houston Company, Fort Wayne Jenney Company, and the Brush Electric Company.

5880 149 R-d Q. In your answers to 63-74 x-Q. you refer to certain tests of lamps constructed with large platinum leading-in wires like those put in evidence on your direct examination. Have the tests to which you referred been continued since your cross-examination. If so, to what extent and with what results?

A. These tests have been continued since that time with the following results: Of Series 1, referred to in my answer to Q 8, the lamps corresponding to Nos.

5881

597 and 598 were continued on test for 446 and 447 hours respectively, when they were removed from the circuits in good condition. Lamp No. 599 was run for 304 hours, and a duplicate of this lamp was run for 71 hours, at which time the juncture of the carbon and platinum developed a defect which practically destroyed the usefulness of the lamp. A third lamp of this type, but with still larger carbon, diameter .066, with platinum leading wire .080, was made recently,
and has been tested 157 hours, and is still in thor- 5882
oughly good condition. Of Series 2, two lamps corresponding in diameter of carbon to Lamp No. 598 of Series 1, and with the same size platinum leading wire, .050 in diameter, were tested for 446 and 467 hours respectively, and are still in good condition. Of Series 3, lamp No. 570 C, having a platinum leading wire of .080 in diameter, has been tested 660 hours, and is still in good condition, as will be seen on inspection. This is the lamp about which I testified in my former
answer to 63 x-Q. In order to still further test the 5883
carrying capacity of a wire of this diameter, a lamp was made having a carbon .075 in diameter. This lamp required a current of 30 amperes at 256 candles and was run on test with this current. This test was terminated at the end of 55 hours by the softening of the glass bulb, which caused it to be forced in by atmospheric pressure, thus destroying the carbon. The platinum wires remained perfectly sealed till the end of the test. Another lamp of this type having a car-
bon .065 in diameter was then made up, and had been 5884
under test 87 hours when I left Pittsburgh, and was still in circuit and in good condition. Three lamps corresponding to Lamps 586 and 587 of this series, having platinum leading wires .050 in diameter, and carbons from .034 to .055, were tested with currents of from 16 to 19 amperes, and were taken from the circuits after a test

5885 of 416 and 447 and 446 hours respectively. These lamps were in good condition when taken from the circuits. Of Series 4 the lamp corresponding to Lamp 593 X, having a platinum leading wire .080 and a carbon .055, was tested at 24 amperes for 467 hours, and was then taken from the circuit in good condition. I might add that, among all the lamps tested as representing the various types given in the five series, only two gave out during the test, and
5886 these I have already mentioned as failing from the sucking-in of the glass in one case and the failure of the joints in the other. The platinum leading wires of .050 and .080 showed no disposition to crack the joints at the seals.

150 R-d Q. Have you the lamps here to which you have referred as having been taken from the circuit, and, if so, will you please produce them?

A. I have here the following lamps: A lamp marked "597 G," referred to above as corresponding to lamp
5887 No. 597; a lamp marked "598:4," referred to above as corresponding to lamp No. 598. This lamp was in good condition when taken from the circuit, but the joint between the platinum leading-in wires and the copper wires, leading to the ends of the carbon, was broken by some mechanical shock in packing. The carbon and the seal are still in good condition, as may be seen from an inspection of the lamp. I have also Lamp No. 619, referred to above as having a carbon .066 in diameter and platinum leading wires .080 in diameter.
5888 This lamp was run with a current of 24 amperes and an electro-motive force of 6.12 volts, and gave a light of 31 candles. I also have Lamp No. 608 E-4, referred to above as corresponding to Lamp No. 598 of Series 1 and having run 446 hours; also Lamp No. 570 C and Lamp No. 623, which I referred to above as having a carbon .065 in diameter and having been under test 87 hours when I left Pittsburgh. This test was con-

tinued after I left for about 40 hours longer before 5889
it was taken from the circuit to send here. I also have Lamp No. 593 X, referred to in my previous answer as corresponding to the Lamp of the same number of Series 4.

> Defendant's Counsel offers in evidence the lamps produced by the witness, and the same are marked respectively Defendant's Exhibit Shallenberger Lamps No. 597 G, No. 598-4, No. 619, No. 608 E-4, No. 570 C, No. 623, 5890
> and No. 593 X.

151 R-d Q. What do these tests show, in your opinion, in regard to the practicability of sealing in the platinum wires of the sizes referred to, so as to produce a permanently tight joint, under the conditions of ordinary use of incandescent lamps?

A. In my opinion they have clearly proven the entire practicability of sealing in such wires, and I have no hesitation in saying that lamps could be made with 5891
entire success on a commercial scale with such wires, if such lamps were required to be used.

152 R-d Q. Why did you not make and test a larger number of lamps of the character referred to?

A. Owing to the difficulty of obtaining platinum of large diameter. A quantity of this wire was ordered immediately after the completion of my cross-examination; but the order was not filled until two or three weeks later, although the makers were constantly urged to forward the wire.

153 R-d Q. Are the defects referred to by you in 5892
your answer to Q. 149 as causing the failure of some of these lamps at all uncommon in ordinary incandescent lamps; and are they due in any way to imperfections in the seal between the platinum wire and the glass?

A. They were such defects as are likely to occur in

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any lamps, particularly where new types are being made. They did not depend in any way upon the sealing in of the platinum wires through the glass.

154 R-d Q. Have you made and tested other lamps with large platinum leading-in wires, and if so, will you please produce them and state how long they have been tested and with what results?

A. I have tested in addition to these lamps others, one of which contained a straight carbon .076 wide and .038 thick, and about 1¼ inches long, and with plat-
5894 inum leading-in wires .050 in diameter. This lamp was tested at 11 amperes, and about 22 candles for 689 hours and I here produce it in good condition. It is marked No. 600 C. A second lamp was tested at 24 amperes and 115 candles for 457 hours. It is numbered 611-10. The carbon in the former of these lamps was made of box-wood; in the latter, of silk.

Defendant's Counsel offers the lamps referred to in evidence, and the same are marked
5895 respectively Defendant's Exhibit "Shallenberger Lamp No. 600 C." and Defendant's Exhibit "Shallenberger Lamp No. 611-10."

155 R-d Q. In your answer to 114 x-Q. you say that lamps "as low in resistance as 5 ohms, for example, or even much less, could be used with most perfect success and in large numbers," in the central-station plant referred to in the question. Please explain more fully what you meant by this answer.

5896 A. I meant in that answer that, provided a demand existed for lamps of sufficiently high candle-power there would be no difficulty in making such lamps for use on the circuits referred to. For instance, a lamp of 600 to 1,000 candle-power of suitable proportions to be placed on a circuit of 100 volts pressure, would about correspond to the resistance mentioned in that answer. A large number of such lamps would require

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an amount of current about proportional to the aggregate candle-power, as compared with an equivalent amount of light produced by lamps of the usual size. As a matter of fact it has been found preferable in nearly all cases to use arc lamps where such a large amount of light is required at one point. A lamp, however, is used to some extent of approximately this candle-power and is known as the Sunbeam Lamp, and is manufactured in London.

Adjourned for lunch. 5898

156 R-d Q. What do you understand to be the pressure used in the Edison central-station plant referred to in x-Q's 110 to 114?

A. I have no accurate information on this point, but understand it is about 110 volts.

157 R-d Q. How common are such districts as you refer to in your answer to x-Q 103 as "selected districts?"

A. Such districts would be somewhat uncommon
and confined to the denser parts of large cities as a 5899
rule.

158 R-d Q. How far, in your opinion would it have been possible to develop the business of central-station lighting commercially, with lamps which were available only for use in such selected districts?

A. It seems reasonable to suppose that central-station lighting would be limited to a few large cities containing areas suitable for distribution under low pressure and not for the supply of current in the
large majority of the smaller towns and cities where 5900
such conditions might not exist.

159 R-d Q. x-Q 103 refers both to defendant's M lamp and defendant's zigzag paper lamp. Would the M lamp be available to the same extent as the zigzag paper lamp referred to?

A. No; the M lamp would not be available for even the same areas of lighting as the zigzag lamp. Under

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similar conditions of cost, and efficiency of distribution, the distance reached with the M lamp would be about three-fourths that of the zigzag lamp.

160 R-d Q. You have testified that very large copper conductors would have to be used with these lamps with the systems of distribution known to the art prior to 1880. Please explain more fully the reason for this, and how improvements introduced into the art since 1880 have modified these requirements?

A. The difficulty in the use of these lamps arises
5902 from the necessity of supplying a practically uniform electrical pressure throughout the system of conductors. The passage of a current through a conductor occasions a loss of available pressure proportional to the amount of current. This loss of pressure causes an irregularity in the pressure supplied to the lamps which becomes more noticeable for a given conductor in proportion as the pressure required normally for the lamp is reduced. In addition to this fact the reduction in pressure at which the lamp is run makes it
5903 necessary to supply a larger quantity of current in order to supply the same amount of energy. From these two causes it results that the loss of energy in supplying a given number of lamps over a given conductor increases as the square of the diminution of pressure; in other words, if the normal pressure of the lamp is 50 volts, the proportional loss of pressure is four times as great as would be the case with a lamp of 100 volts supplied over the circuit. The practical effect of this is that lamps supplied near-
5904 er the source of current by a multiple-arc system of distribution such as was known at the time referred to would be subjected to an unduly high pressure, while those distant from the source might be at or below their normal pressure. If, to obviate this difficulty, lamps of different voltages were employed, the result would be that when a small number of lamps were

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being supplied with current those nearest the source would be supplied with an insufficient pressure, while the more distant lamps of lower voltage might be supplied at a pressure equal to or above their normal pressure. It has been found that a variation of even 5 per cent. in pressure interferes seriously with the satisfactory operation of the lamp. To maintain a uniform pressure within such limits as this over a large
area, under varying conditions of load, conductors of 5906
excessively large diameter would be required, whose cost would be such as to render their use a commercial failure. The improvements in distribution designed to overcome these defects have been of the nature of feeder circuits, supplying mains upon which the lamps are placed and in such a way that the loss of pressure in the feeders does not cause irregularity in the lamps. In addition to this the system of distribution known as the three-wire system is used by which the electrical
pressure for a given type of lamp may be double that 5907
required by the lamp itself, and in addition to this is the alternating-current transformer system by which the low-pressure circuits are limited to short distances and supplied by high-pressure currents over long distances.

161 R-d Q. Do variations in pressure affect the durability of the lamps?

A. Yes, variation in pressure has a very decided effect on the durability of lamps; a slight increase in
pressure shortens the life of a lamp to a degree much 5908
more than proportional to that increase.

162 R-d Q. How does the multiple-series system referred to in cross-questions 115 to 118 differ from the multiple-arc or parallel system of distribution?

A. In the multiple-arc system the lamp is connected directly across the two mains so that each lamp is independent of every other lamp. In the multiple-series

5909 system two or more lamps are connected in series with each other and these series groups are connected across the mains.

163 R-d Q. Is the multiple-series system an equivalent for the multiple-arc system or equally available for central-station lighting?

A. No, it is not, for the reason that the interruption of the current in any lamp of a group interrupts the current in the other lamps of that group when lamps
5910 are operated in multiple series. In order to overcome this difficulty some additional appliance is required which renders such a system more or less complicated and impracticable. As a a matter of fact multiple-series systems have never been very largely introduced.

Re-cross examination by Mr. Dyer:

164 R-x Q. Referring to your answer to 145 R-d Q. the effect of the alternating-current transformer system is to bring the low-tension source of current closer
5911 to the lamps, is it not?

A. Yes.

165 R-x Q. Are the lamps connected in multiple arc with these low-tension sources of current?

A. Yes.

166 R-x Q. What is the voltage of the lamps you use with this system?

A. 50-volt lamps in nearly all cases.

167 R-x Q. How many of these lamps do you use in multiple arc on the same low tension circuit in the
5912 transformer system?

A. Usually from 10 to 40 lamps. The greater number of such circuits supply 20 lamps, and in some cases more than 40 are placed in one circuit, where there is difficulty in arranging otherwise.

168 R-x Q. What is the capacity, in number of 16-candle lamps, of the largest sized transformer you make?

A. 40 lights is the largest single transformer made

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by the Westinghouse Company, except a few recently made for special cases. The company also sells an 80-light transformer made of two 40-light units. Very few of these are made. The special converters referred to have a capacity of 100 lights.

169 R-x Q. Have you not in some instances coupled the low-tension or secondary circuits of converters together, so as to increase the number of 50-volt lamps used in multiple arc on the same circuit beyond any number you have given? 5914

A. Yes. This is what I referred to in my answer 167 where I mentioned the difficulty of arranging otherwise. This coupling together of converters is done by the local or construction companies to a limited extent, where the primary current cannot be readily connected at a sufficiently large number of points. I believe in some cases 200 or 300 lamps are so connected.

170 R-x Q. The operation of these 200 or 300 lamps in multiple arc on the same circuit by coupling a number of converters together, presents the same condi- 5915 tions, so far as the size of conductors is concerned that would be presented by using a dynamo located where the converters are and supplying the lamps directly from the dynamo?

A. Yes, and it is for this reason it is found necessary to subdivide the low-tension circuits as much as possible since the increase in cost of conductors is very important even where 200 or 300 lamps are connected in the same circuit.

171 R-x Q. Do you know of any instance where 5916 more than 300 of your 50-volt lamps have been used in multiple arc on the same circuit.

A. I do not now recall any case in which more than that number is used, but I think it quite possible that some case or cases may have arisen where such an arrangement proved desirable for reasons independent of the cost of the secondary or low-tension circuits.

172 R-x Q. It might be inferred from your answer to R-d Q 145 that you thought that central-station light-

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ing except by alternating-current apparatus is not a
commercially successful enterprise. Were not large
central stations in operation using direct-current appar-
atus before the alternating-current system was intro-
duced in the fall of 1886, and are not such stations
still being operated and new stations of similar charac-
ter installed?

A. Yes, such stations are still in operation and I pre-
sume in many cases with commercial success. What I
5918 had in mind at the time of giving the answer referred
to, would perhaps be better stated by saying that in a
very large number of cases the improvements in direct-
current distribution still fall short of the requirements,
and that central-station lighting has only become pos-
sible in its most extended sense by the use of alternat-
ing currents.

173 R-x Q. That is to say, it is possible to reach out
further, or run greater distances with the alternating-
current system than with the direct-current system?
5919 A. Yes, that is the case.

174 R-x Q. Taking the average number of lamps used
in the Edison direct-current, central-station plants
throughout the country, how does it compare with the
average number of lamps used in the Westinghouse al-
ternating, current transformer plants in the United
States?

A. I do not know.

175 R-x Q. Would you be surprised to know that
the average number of lamps is greater in the former
5920 class of central-station plants than in the latter?

A. No, I would not be surprised to learn this because
I know it to be a fact that the Edison Company had in-
stalled several large plants in densely populated district
before the Westinghouse Company began to introduce
the alternating-current system. I would, however,
be very much surprised to learn that the average dis-

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tance of lamps from the central station is not very
much greater in the Westinghouse plants installed
than in Edison plants.

176 R-x-Q. What are the additional appliances re-
ferred to by you in answer to R- Q. 163?

A. I referred to such appliances as have been used
for the substitution of a resistance practically equiva-
lent to that of the lamp, through which the current is
caused to pass when interrupted in the lamp itself.
The disadvantage of this arrangement lies in the fact 5922
that the same amount of energy is required whether
the lamp is turned on or off. Such a system is only
useful under such circumstances as require a practi-
cally constant number of lamps in circuit, as for in-
stance, in the lighting of streets.

177 R-x Q. But multiple-series systems without such
appliances have been introduced, have they not? If
so, to what extent?

A. I believe such systems have been used in a limi-
ted way, but, I believe, not to any very great extent, 5923
and I do not know of any company now regularly in-
stalling such systems.

178 R-x Q. To what extent, if at all, have the mul-
tiple-series systems, with the appliances referred to in
answers 163 and 176, been introduced?

A. Very little on a commercial scale, and usually by
arc-lighting companies to supply a few lights on arc
light circuits. The method of connection is however
somewhat different in this case, although the substitu-
tion of resistance is quite as necessary.

179 R-x Q. Referring to your answer to Q. 32, did 5924
not the problems which you solved as a student include
the arrangement of resistance in multiple series as
well as in multiple arc and in series?

A. Yes, that is my recollection.

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180 R-x Q. And the multiple-series arrangement of resistances or other electrical apparatus was one well understood at the time referred to in Answer 32?

A. Yes.

181 R-x Q. In answer 32 you state, "It therefore "appears to my mind that the method of operating "lamps in multiple arc would have been so well under-"sood at this time as to render it a matter of easy cal-"culation to determine what would be the proper
5926 "change to make in suiting lamps having low-resist-"ance conductors for use in multiple arc." Is not this statement equally applicable to the operation of lamps in multiple series?

A. Yes, although no such change would be required to operate in multiple series.

182 R-x Q. That is to say, the known conditions relating to the use of resistances and other electrical apparatus in multiple series would have made it understood that electric lamps could be arranged in multiple
5927 series without changes in the lamps themselves?

A. Yes, I should think so.

183 R-x Q. In answer to x-Q. 95, you furnished a table of measurements of certain parts of your commercial lamps. Will you furnish me with a revised table giving me the length of the carbons and the resistances, measured cold, of these same lamps?

A. I have prepared such a table, and furnish it herewith, and have; in preparing it made; some corrections in the former approximate figures given; the following
5928 is the table:

Volts.	Candle Power.	Diam. of Wire. Inches.	Diam. of Carbon. Inches.	Length of Carbon. Inches.	Resist. of Carbon. Ohms.
50	10	.016	.0055	4.81	148.4
"	16	.016	.0079	6.12	85.9
"	25	.018	.0092	7.12	64.5
"	32	.020	.0099	7.63	55.6
"	50	.022	.0129	9.13	37.9

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Volts.	Candle Power.	Diam. of Wire. Inches.	Diam. of Carbon. Inches.	Length of Carbon. Inches.	Resist. of Carbon. Ohms.
"	75	.033	.0172	10.16	26.3
100	10	.014	.0054	7.63	480.8
"	16	.014	.0068	7.63	321.6
"	25	.016	.0083	7.63	252.0
"	32	.016	.0080	8.13	235.0
"	50	.018	.0117	9.38	111.3
"	75	.028	.0139	10.91	89.8

184 R-x Q. What is the lamp I now hand you? 5930

A. This lamp appears to be a 50-volt 150-candle-power lamp made at the Sawyer-Man factory 23d street, New York City, having two carbons of 75-candle-power each, coupled in parallel at one extremity and led to separate terminals at the other extremities.

185 R-x Q. Is it not one of your regular 150-candle-power 50-volt lamps having two carbons of the dimensions stated for the 50-volt, 75-candle lamp in the tables given in answer 95 and in answer 183?

A. It appears to be such a lamp, though I have no 5931
means of verifying the exact dimensions.

Counsel for Complainant, offers in evidence the lamp referred to, and the same is marked "Complainant's Exhibit, Westinghouse 150-candle, 50-volt lamp."

OLIVER B. SHALLENBERGER.

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NEW YORK, January 22d., 1890.

Met pursuant to adjournment:

Present: CLARENCE A. SEWARD and RICHARD N. DYER for complainant, and SAMUEL A. DUNCAN and LEONARD E. CURTIS, Esquires for defendant.

FRANK S. SMITH, called on behalf of the defendant being first duly sworn, deposes and says in answer to
5934 interrogatories:

1 Q. Please state your name, residence and occupation.

A. Frank S. Smith 26 Pittsburgh; electrician in the employ of the Westinghouse Electric Company.

2 Q. State briefly what your position is in the said company at present.

A. I have charge of the department for manufacture of filaments used in the preparation of incandescent
5935 lamps manufactured by this company, I also have charge of all the experimental work in connection with these lamps.

3 Q. Please state whether you have read the deposition of Mr. Shallenberger given in this suit, and whether you aided him in making the various exhibit lamps that have been put in evidence in connection with his said deposition, as also in making the various tests in connection with these lamps and about which he has testified, and if so, whether you can verify the
5936 various statements and data which he has given in the premises.

A. I have gone over all the testimony given by Mr. Shallenberger. I have been associated with him in the preparation of the lamps offered in evidence in this suit, together with the lamps offered in the prior

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suit, spoken of as the McKeesport suit. I am thoroughly acquainted with the methods of preparation of these various lamps, with the various data given as to their electrical properties and can verify the statements made by Mr. Shallenberger in connection therewith. The statements made by Mr. Shallenberger and the data given by him are correct.

Complainant's counsel waives cross-examination of Mr. Smith.

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FRANK S. SMITH.

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James A. Vandegrift being called as a witness in behalf of defendant, and duly sworn, testifies in answer to interrogatories by S. A. Duncan, as follows:

1 Q. What is your name, age, residence and occupation?

A. James A. Vandegrift, age 28, residence, Newark, New Jersey, manufacturing incandescent electric lamps in the Sawyer-Man Electric Company.

2 Q. Have you ever been connected in any capacity
5942 with the defendant in this suit, the United States Electric Lighting Company?

A. I have, having charge of the manufacture of their incandescent electric lamps for three and a half years. I went into the employment of the United States Electric Lighting Company in January, 1880, and continued with them until May, 1889.

3 Q. Did you furnish the data embodied in the stipulation in regard to the character of defendant's lamps in evidence in this case?

5943 A. I did.

4 Q. Please state whether the lamps covered by that stipulation (being the stipulation found upon pages 58 and 59 of complainant's printed record) were specially prepared for this case, or were taken from the regular stock of lamps in the United States Lighting Company?

A. They were taken from the regular stock.

5 Q. So far as you know, are the three lamps covered by said stipulation fair average samples of the lamps manufactured by the said company?

5944 A. They are.

6 Q. Will you briefly indicate the process by which the carbon burners of the three classes of lamps referred to in the aforesaid stipulation were made by the defendant corporation?

A. They were stamped out of the different materials, paper or tamadine by punch and die, then carbonized, treated in a hydro-carbon vapor, mounted, exhausted, then finished by putting on the base of the lamp.

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7 Q. What is the "treatment" to which these carbons are subjected after carbonization?

A. They are put under a receiver, which receiver is exhausted of air, hydro-carbon vapor is then admitted in an attenuated condition, the current is then passed through the carbon, heating it up and depositing the carbon from the hydro-carbon vapor.

8 Q. What is the effect of this hydro-carbon treatment upon the specific resistance of the carbon as it comes from the carbonizing furnace? 5946

A. It decreases it. In the case of the tamadine carbon the decrease is about fifty per cent., in the case of the paper carbons the decrease is ninety per cent.

9 Q. Did this change in the specific resistance of the carbons under the hydro-carbon treatment characterize the manufacture of these burners for incandescent lamps by the United States Company prior to the year 1885?

A. It did.

10 Q. How thoroughly has it been the practice of 5947
the United States Electric Lighting Company to carbonize their burners previous to the hydro-carbon treatment?

A. Up to that point at which all extraneous material was eliminated and short of any wasting away process.

11 Q. Giving you then substantially a pure carbon product?

A. Yes.

12 Q. And it is with reference to carbons of this
character that you have said that the specific resis- 5948
tance is reduced 90 per cent. in case of paper, and 50 per cent. in case of tamadine by the hydro-carbon treatment which is practiced by the United States Company in the manufacture of their burners?

A. It is.

13 Q. What is the condition of the carbon formed from paper, as to strength and flexibility when it

5949 comes from the carbonizing furnace and before it is subjected to the hydro-carbon treatment?

A. It is quite fragile; so fragile that it could not be handled commercially on account of the enormous breakage.

14 Q. Do you mean by this that it would be impracticable to use such carbons in the manufacture of commercial lamps?

A. I do.

15 Q. In your answer to question 7 you say that in

5950 treating the carbons, hydro-carbon vapor is admitted to the receiver in an attenuated condition. Please explain what you mean by this?

A. We first exhausted the receiver of air and then admitted the hydro-carbon vapor to a very slight extent or in a very small quantity. The pressure of the hydro-carbon vapor after closing the supply would be then about .015 of an atmosphere.

16 Q. What was the purpose of treating the carbon in an attenuated atmosphere of this kind rather than

5951 in an atmosphere of hydro-carbon vapor at atmospheric pressure?

A. To make the deposition of carbon take place internally, and fill up the pores, rather than to deposit it on the outside of the carbon.

NEW YORK, January 25, 1890.

Cross-examination of JAMES A. VANDEGRIFT by MR. DYER:

5952 17 x-Q. Why did you leave the United States Company in May, 1889?

A. To enter the employ of the Sawyer-Man Electric Company.

18 x-Q. What change, if any, in the business of the United States Electric Lighting Company caused you to make this change?

—5953

A. Its lease by the Westinghouse Electric Company?

19 x-Q. Please explain what change in the business this produced so far as it affected you?

A. The manufacture of incandescent lamps was transferred from the factory of the United States Company to that of the Sawyer-Man Company.

20 x-Q. Were you in charge of the manufacture of incandescent lamps for the United States Company for the three and one half years preceding May, 1889?

A. I was.

21 x-Q. Can you explain to me the several commer- 5954
cial types of incandescent lamps made and sold for commercial purposes for the United States Company at and about the time you left the employment of that Company, giving for each lamp the following data: candle-power, volts, amperes, cross-sectional dimensions and length of the carbon, material from which the carbon was made, diameter of the platinum wires, and the resistance, measured cold, of the lamp?

A. I am not able to give all the data without reference to my notes, but will prepare a tabular statement, 5955
and hand it to the Examiner.

22 x-Q. What was the ratio between the resistance of those lamps when measured cold and when measured at their normal resistances?

A. About 50 per cent. The hot resistance was about half of the cold.

23 x-Q. Were all these lamps of which you will furnish me a table, provided with exhausted glass enclosing-globes, sealed at all points by the fusion of the glass, and with platinum leading-in wires sealed by the 5956
fusion of the glass upon them, substantially like Complainant's Exhibit "Defendant's zig-zag" and "Defendant's M Lamp?"

A. Yes, with exception of details in manufacture.

24 x-Q. You have spoken in answer 8 of the decrease in specific resistance of tamadine and paper car-

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bons due to the hydro-carbon treatment. Were all the paper and tamidine lamps made under your direction for the United States Company provided with carbons subjected to these large reductions in specific resistance?

A. They were not. The lamps that did not have this reduction due to hydro-carbon treatment were tamidine carbons not treated at all. These lamps we commenced to manufacture in the latter part of 1888
5958 and since that time.

25 x-Q. Did you ever try the experiment of manufacturing paper carbons with a higher degree of carbonization than that employed in carbons requiring the 90 per cent. reduction.

A. I did.

26 x-Q. What effect did this have on the specific resistance of the paper carbons and also upon their fragility?

5959 A. It made them so fragile that I was unable to make any tests on their specific resistance. This was only a rough experiment as this general ground had been gone over by others in the company before, as I understood.

J. A. VANDEGRIFT.

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Lamps made by the 5961

UNITED STATES ELECTRIC LIGHTING COMPANY,

in May, 1889.

Material	C-P.	EMF	Amp.	Cold Resist	Length.	Width	Thickness.	Diameter of Wires.		
Paper.	16	60	1.4	75	4.25	.024	.0055	.025		
"	20	60	1.2	105	6.2	.012	.004875	.016		
"	16	70	.9	150	6.2	.012	"	.012		
"	20	70	1.1	117	5.8	.0145	"	.016		
"	25	70	1.3	98	"	.0185	"	.018		
"	32	70	1.8	73	"	.0235	"	.025		
"	50	70	2.8	50	"	.0355	"	.030		
"	80	70	4.4	34	"	.0595	"	.030	Double.	5962
"	100	70	5.4	26	"	.074	"	.030	"	
"	16	80	.75	200	6.2	.012	"	.012		
"	125	110	3.	77	10.3	.031	.0055	.018	Double	
"	125	150	2.4	128	10.3	.031	"	.018	"	
Tamadine.	16	25	1.	50	2.4	.0078	.0033	.016		
"	16	30	1.2	50	2.5	.0105	"	.018		
"	16	35	1.3	52	3.25	.0105	"	.025		
"	16	40	1.	80	3.5	"	"	.018		
"	16	45	1.	90	4.25	"	"	.018		
"	16	50	1.	96	4 5	"	"	.018		
"	32	50	2.2	42	5.25	.023	'	.030		
"	16	60	.9	130	5.	.0105	"	.016		
"	16	70	.75	180	5.	"	"	.012		
"	32	70	1.5	92	5.25	.023	"	.025		
"	25	70	1.1	125	5.25	.0155	"	.018		5963
"	50	70	2.54	58	5.25	.042	"	.030		
"	16	110	.52	400	6.5	.0078	"	.012		
Tamadine.	16	50	.85	105	2.2	.0155	.0033	.012		
"	16	60	.8	131	2.6	"	"	;012		
"	16	65	.9	124	3.	.0185	"	.016		
"	10	70	.55	225	3.2	.0105	"	.012		
"	16	70	.8	153	3.3	.0155	"	"		
"	16	100	.57	305	4.6	.0105	"	"		
"	16	105	.54	335	4.75	"	"	"		
"	10	110	.33	580	4.5	.0058	"	"		
"	16	"	.55	345	5.	.0105	"	"		
"	20	"	.7	270	5.25	.0135	"	"		
"	25	"	.9	210	"	.0155	"	.016		
"	32	"	1.1	173	"	.023	"	.016		
"	50	"	1.7	114	"	.042	"	.025		5964
"	80	"	2.8	68	"	.053	"	.030		

Tabular statement produced by the witness, James A. Vandegrift and added to his deposition.

Jan'y 27, 1890, S. M. H., Exr.

5965 UNITED STATES CIRCUIT COURT,

SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT COMPANY.

vs.

THE UNITED STATES ELECTRIC
5966 LIGHTING COMPANY.

In Equity No. 3445.

BOSTON, MASS., February 4th, 1890

Present:

CLARENCE A. SEWARD AND R. N. DYER, Esqs., for Complainant.

SAMUEL A. DUNCAN AND LEONARD E. CURTIS, Esqs., for Defendant.

5967 ELIHU THOMSON, a witness produced on behalf of the defendant, being duly sworn, testified as follows, in answer to questions by counsel for defendant.

1 Q. What is your name, age, residence and occupation?

A. Elihu Thomson, thirty-seven, Lynn, Mass., Electrician of Thomson-Houston Electric Company, and Thomson Electric Welding Company.

2 Q. What acquaintance have you with the laws of electricity, and the practical application of those laws
5968 to electric lighting?

A. I have a large acquaintance with the laws of electricity and the application of the force in prac-

tice. My study of the science began at an early age, 5969
and I was accustomed to work with batteries in the operation of arc lights, and the heating of metallic wires prior to the year 1870, since which time a large portion of my work has been in this same field.

From the year 1870 until 1876, I was engaged as assistant professor of chemistry and physics in the Central High School at Philadelphia, at which time I had charge of the laboratory and a large collection of physical apparatus, including electrical devices, voltaic batteries, etc. I frequently lectured in public on scientific subjects including electricity. In 1876 I became professor 5970
of chemistry and mechanics in the same institution, which position I held till about the middle of 1880. During this period I made very many experiments in electrical matters, and in 1877 was selected by the Franklin Institute of Pennsylvania to deliver a course of lectures on electricity; and later in the same year was appointed one of a committee of the Franklin Institute to make investigations of measurements concerning the properties of dynamo-electric machines then on the market, the report of which committee when published became authority on dynamo machines 5971
at the time, and developed for the first time certain of their properties. During this period also I made quite a large number of pieces of electrical apparatus, many of them involving original ideas, and tried numerous experiments, a large majority of which were connected with the subject of electric lighting. I developed at the same time a system of electric arc lighting which has gone into extensive use; much of this work was done in conjunction with Professor E. J. Houston of Philadelphia. I made a trip abroad in 1878, visiting the Paris Exposition in that year and studying particularily the Jablochkoff candles and 5972
system of lighting by electricity.

In the year 1879, arrangements were made for the

5973 manufacture of electrical apparatus used in our arc
system of electric lighting, which led up to the organization in 1880 of the American Electric Company
of Connecticut, now the Thomson-Houston Electric Company. Since this time I have been connected with this organization, and have developed a
large number of inventions in electric lighting in connection with which I have made many thousand experiments in electrical actions. This work has continued without intermission up to the present time.
Large numbers of the inventions and apparatus
5974 brought out have gone into practical use.

I have, besides the work of designing, carried on the instruction of workmen and experimenting; have contributed at times to the technical and electrical journals; and have besides invented and developed a system of welding and working metals based on the laws of electrical heating.

In general my work has for the past 15 to 20 years been of that character which renders me familiar with the very many phases of electrical action, with the details of construction of electrical devices, with the
properties of these devices when in use, and with the
5975 technical construction and installation of electric apparatus generally for lighting and power purposes.

I have, in addition, had a mechanical training which has given me manual skill in construction, an intimate knowledge of processes and appliances connected with the art of electric lighting and other arts; and my training as a chemist has been such as to make me familiar with the chemical changes produced by heat, light, or electricity in the nature and composition of substances generally. During this period
also I have endeavored to keep track of the publica-
5976 tions, both technical and scientific, connected with
the subject of electricity and kindred sciences, besides doing a large amount of reading in the literature existing prior to the period mentioned.

2 Q. I think that you received some recognition at 5977
the Paris Exposition of last year on account of your work as an inventor and investigator in the domain of electricity. Will you please state what that was?

A. Yes, I was awarded the Grand Prix for electrical inventions, and was made an officer of the Legion of Honor by the French Government.

3 Q. Is the Thomson-Houston Electric Company, with which you are connected, engaged in the business
of incandescent lighting as well as arc lighting? 5978

A. It is.

4 Q. Have you read and examined the patent in suit, United States Letters Patent No. 223,898, granted to Thomas A. Edison, January 27, 1880?

A. Yes. I have been familiar with the patent since its issue and have examined it carefully.

5 Q. Are you familiar with the construction of the different forms of incandescent lamps which have been
put into commercial use in this country and abroad? 5979

A. I believe I am, so far as it is possible to become familiar by constructing lamps of various types and without visiting the various workshops in different parts of the world. I have been directly connected with the manufacture of incandescent lamps as an expert in such matters. I have seen many forms or makes of incandescent lamps, watched their development, and have frequently tested them. I am also fairly familiar with what has been written or published in regard to their construction.

6 Q. Have you ever known of incandescent lamps 5980
being made and sold which were constructed like the lamp described in the specification, and shown in the

5981 drawing of the Edison patent in suit; that is, with the carbon burner made from a wire of tar-putty, coiled into a spiral and united to the platinum wires before carbonization?

A. No. I have never known of such lamps ever having been made or introduced commercially, nor do I believe that they have ever been so introduced or made.

7 Q. Have you ever known of incandescent lamps being made and sold in which the burners were made
5982 of tar-putty, or any other material, united to the platinum wires by means of a plastic composition before the carbonization of the burner?

A. No; I do not believe that any such incandescent lamps have ever been made or sold. I certainly have never heard of any in which the burners were so united to the wires before carbonization, nor do I know of any.

The belief in the last two answers is objected to as incompetent, irresponsive and partisan.

5983 8 Q. Would it, in your opinion, be practicable to make a serviceable lamp constructed in the manner shown in the drawing and described in the specification of the Edison patent in suit (that is, a lamp with a carbon burner made from a wire of tar-putty, coiled into a spiral and united to the platinum wires before carbonization), without making use of inventions not described in the patent and not known to the art at the date of the application for the patent?

Please give your reasons for any opinion you may express.

5984 A. It would not, in my opinion, be practicable, as there are a great many difficulties in the way of producing a serviceable lamp in that manner.

In stating my reasons I will even assume that the 5985
lamp is not to be of any standard; that is, that it is not to be exactly like, or practically like, some other lamp made in the same way, but is merely to be a serviceable source of light obtained by the incandescence of the material heated by the passage of a current. In the first place, we have as an obstacle the difficulty of producing such a thin, uniform thread of tar putty as is described in the specification—that is, such a thread of less than one one-hundredth of an inch in diameter, or more definitely about seven one-thousandths, a size which is something like a coarse 5986
hair—and the length of which is to be a number of inches according to the specification. But assuming that such a thread could be made of uniform diameter in spite of the difficulties, it is then to be coiled into a helix or spiral, a manipulation which, with such a material in its plastic condition, would be an exceedingly fine manipulation—almost impossible in fact without stretching or further deforming the plastic thread; but the specification states how this is to be done, or at least points out how such a thread may be supported during carbonization, which is to wind it 5987
upon a spiral of copper, coiling it in this manner directly in contact with the copper, after which it is to be carbonized (leaving out for the present the attachment to the wires). Being a tar composition, it would naturally, on heating, first soften; but nothing is said of any means of protecting or supporting it in this condition except the winding on the copper. During carbonization the material will shrink, but the copper will expand by the increased heating, and we will have the case of a spiral shrunken in dimesions around a copper spiral enlarged in dimensions, with the result, 5988
in my opinion, of almost inevitable rupture of the carbon spiral during carbonization. Being a plastic ma-

5989 terial and first softening by the heat, it will tend to
cement itself to the copper, just as the mass at the
ends is relied upon to cement itself to the platinum
terminals. This sticking action seems to me to be
admitted when it is proposed in the specification to
remove the copper by acid after carbonization, but in
my opinion the spiral would not be intact, and, fur-
thermore, if the carbonization was made at a tempera-
ture to sufficiently carbonize such a material, the cop-
per would not be intact but would have been melted
in part or entirely during the operation. It cannot
5990 be said here, however that the melting would relieve
the shrinkage mentioned and save the carbon spiral
from rupture, because the material will have become
solid or rigid before the copper melts. Nothing is
said in the specification for relieving the carbon spiral
in any way from the conditions just mentioned.

Another difficulty, however, with the tar-putty com
position is involved in the formation before the car-
bonization of a joint with the platinum wires. This
joint as shown is comparatively massive; the wires
themselves are heavy and are supposed to be sustain-
5991 ed on the projecting ends of the coiled thread during
carbonization. Now it must be remembered that this
composition is practically limber and without rigidity
during carbonization and throughout the heating, and
that it undergoes a shrinkage during this action; that
it is exceedingly slender; that no method of support-
ing the wires or joints independently of the coil to
allow the shrinkage is either pointed out, suggested,
or in any way hinted at in the specification. In fact
no statement at all is made of the manipulations re-
quisite, or which would certainly be requisite even if
they could be adopted with success, to secure this ex-
5992 ceedingly frail and uncertain structure during this
carbonization process.

A further difficulty is in getting a thorough degree

of carbonization throughout the structure and without 5993
rupture or displacement of parts. Nothing is said
about winding upon a shrinkable mandrel or a man-
drel that would shrink as rapidly as the tar putty it-
self. These and other such devices, which would I
think be necessary in order to succeed at all, would be
in the nature of separate inventions or subsequent de-
velopments.

If we can assume that numerous trials with varying
arrangements and the exercise of considerable inventive
skill has secured us a carbon thread in a coiled shape
such as is contemplated in the specification, I greatly 5994
doubt whether the position of the turns of the coil
would be at all uniform, whether the conducting power
and cross-section of the carbon would be uniform
throughout its length. If the question includes in its
scope the coiling of a carbonizable material such as
cotton thread and the cementation of the same to the
platinum wires before carbonization, then I would say
that in my opinion the difficulties would be as great
and in some respects greater in securing the objects
set out in the specification by such a procedure. A
thread would not, in my opinion, be easily coiled which
would, when carbonized, remain with its coils evenly 5995
spaced apart. In order to secure the object set out in
the specification of a small radiating surface, the coils
or turns of the coil require to be closely adjacent, and
if they vary in their distance apart at different parts
of the coil, and in this condition are heated by the
current, those portions which are closely adjacent will
be at too high a temperature as compared with those
which are wider apart; the difficulty of obtaining a
coil with evenly spaced turns is a direct consequence
of the tendency of all materials to warp during car-
bonization and at the same time to shrink in the length 5996
unequally; this fault, in my opinion, would be so great
in a closely wound spiral as to short-circuit a portion

5997 of its turns by contacts laterally. The specification
says in substance that in such case—that is, that in
case of a thread carbonized—the coil may be wound
with the intervening spaces filled with non-conducting
material, that is, that the spiral might be a close spiral
with turns held apart by an intervening non-conductor.
In my opinion this would be impracticable, simply because
such material would conduct under high temperatures,
and the passage of current across it would
wear out the carbon very rapidly.

A further difficulty, and a very serious one, is the
5998 fact that the joints with the platinum wires, being
made of lumps of the tar-putty composition, would,
after the lamp was finished, give out gases gradually
and spoil the vacuum. This would occur in virtue of
the property of spongy carbon masses to retain gases
and only gradually to give them up on prolonged heating.
The effect of the yielding up of the gases in any
portion of the lamp would be to run down the vacuum
to a point at which it becomes semi conducting, particularly
in the presence of a radiating or illuminating
surface; which leak of current around in the vacuous
5999 space would, together with the low vacuum itself, destroy
the lamp. The lowering of the vacuum also
would reduce the brilliancy and economy very greatly.
No procedure whatever is pointed out in the specification
whereby this difficulty may be avoided. It is
such a difficulty as in my opinion would take away the
serviceability of an otherwise good lamp, which this
structure certainly is not.

There are other decided objections which would, I
think, destroy the serviceability of the lamp and lead
it to be discarded even if the difficulties above pointed
out were removed or overcome. If the carbon be
coiled to an extent to reduce the external illuminating
6000 surface as compared with the total illuminating surface
of the incandescent carbon, a condition distinctly

set out as an object attained by the lamp in question, 6001
the interior surface of the spiral would be subjected
to vigorous radiation and be at a comparatively much
higher temperature than the exterior surface. The interior
of the spiral would be, as it were, a furnace as
compared with the exterior of the spiral—a focus of
interior heat and radiation. It is an essential that
the highest-temperature portion of a lamp be exposed
for radiating light, as the light given out increases
enormously with the temperature, while the durability
of the carbon itself decreases enormously with increased
temperature. Hence, in this lamp we have 6002
the anomolous condition of shutting in a portion from
radiation, and damaging the carbon thereby on account
of high temperature, and letting the light
radiate from the outside at much lower temperature.
Were the carbon of a high resistance a good conductor
for heat, which it is not, this difficulty would
not be so great, though the radiation in the interior
of the coil would cause it to be present. If the spaces
between the turns of the coil were wide enough to
allow of free radiation from its interior as well as its
exterior, then the difficulty would diminish without
disappearing, but at the same time the advantage 6003
claimed of reduced radiating surface would have also
disappeared or nearly so.

Another disadvantage may be mentioned, and this
is by no means a slight difficulty in the way of the serviceability
of the lamp in question. It is, as simply
stated, that whereas in an incandescent conductor for
emitting light all parts should be kept at substantially
the same temperature so as to be economical and efficient,
the middle portions of the coil of carbon in the
lamp in question will always be hotter than the portions
near the end of the coil. This is the simple consequence
of the fact that at the ends of the coil free 6004
radiation can occur from both interior and exterior

6005 surfaces of the turns, while at the middle of the coil
the interior radiation is practically absent.

It is my experience that where such unequal heating
as is here shown to be inevitable takes place, the dur-
ability of the lamp is most problematical, to say the
least; that wherever the turns of the carbon conductor
are at certain portions near together and able to
counterradiate, if I may use the term, rapid destruc-
tion or evaporation of the carbon takes place, and
further that in incandescent conductors generally the
weakening at one place results in greatly increased
6006 weakening at the same place or place of highest tem-
perature on account, apparently, of the fact that, con-
trary to the statement in the specification of the pat-
ent in suit, carbon is not stable in the highest vacuum
when the temperature is carried to too high a point,
but that the instability increases very rapidly with
increased temperature at any point, owing to a sort of
evaporation or volatilization of the carbon at the
overheated portions.

Adjourned to February 5th. 1890.

6007 Boston, Mass., February 5th, 1890.

Met pursuant to adjournment.

Present: Counsel as before.

Examination of the witness Thomson continued.

9 Q. Are there any advantages connected with the
coiling of a carbon burner into a close spiral; and if
so, what?

6008 A. Yes; aside from the disadvantages and difficulties
which I have pointed out in my previous answer, there
may be the advantage of better support in the case of
a very long conductor. Such a conductor if not coiled

would spread over a considerable space, and portions 6009
of it might be too far away from the point of attach-
ment to the wires for stability. The coiled form
would reduce the mechanical strain on the attached
ends.

By coiling, also, the carbon conductor can be made
of great length, so as to secure a high resistance in the
burner aside from its specific resistance, without there-
by causing it to expose too much radiating surface, or,
in other words, securing thereby a small radiating sur-
face comparatively to the total surface, which is one
of the objects distinctly pointed out in the specifica- 6010
tion.

Another effect of this coiling would be that the car-
bon conductor would run at a much higher tempera-
ture than if it were not coiled but spread out. This
increased average temperature of the whole spiral
would be a direct result of the decreased radiating sur-
face. This latter advantage, as it may be termed, is
altogether outweighed by the considerations pointed
out in my previous answer; and while, if the fact
stood alone,it might be an advatage to coil the carbon,
the coiling operation would, in my opinion, bring into
action other detrimental influences which make me 6011
doubt that any advantage can be attached to the coil-
ing.

10 Q. Assuming that a lamp like that shown in the
drawing of the Edison patent in suit might be made
by processes known to the art at the date of the pat-
ent, could such lamp, in your opinion, be made and
used commercially, even if improved lamps had not
been devised subsequently?

A. It could not in my opinion be used commer-
cially. The condition of commercial use is that of 6012
supplying, as pointed out in the specification, large
numbers from the same mains in multiple-arc or with

6013 the same electric pressure from the mains. Now, one of the prime conditions of such use is that the degree of temperature or incandescence of the carbon conductor shall be as nearly as possible uniform in all the lamps or burners. This means that the relation between the heat-producing energy of the current passing through each lamp in relation to the effective radiating surface, shall be the same, or, at least, shall not run below or above certain proportions. If this relation is changed in such a way as to lessen the heat energy given out per unit of effective radiating surface be-
6014 low a certain point, the economy of the particular lamp would be very much less than it should be as compared with others in the same system. In other words, the heat energy would be simply wasted in large part.

On the other hand, if in certain lamps of the system the proportion of the heat energy developed is excessive, the destructive effect of high temperature becomes very greatly intensified and destroys the carbon; hence the first desideratum is to secure in a number of lamps used together uniformity of radiating power
6015 per unit of radiating surface.

Besides the great disadvantage just pointed out of failure in this respect, there is, in addition, the fact that such uniformity of radiation is requisite to secure the same color of emitted light from all the lamps. If any of them run at low temperature, the light besides being enfeebled will become red, while others that run at high temperature become too brilliant and white.

But, again, there is required also in the lamps of a system, not only the uniformity of radiation per unit of surface, but in addition a fairly uniform amount of
6016 effective radiating surface for a lamp of the same candle-power as another.

In my opinion the lamp referred to in the question

could not be made commercially of sufficient uniformity 6017
to satisfy the two conditions just pointed out, even though it be assumed that the difficulties I have enumerated in my answer to question 8 were not fatal to it. In my opinion it would be practically impossible to secure by the methods pointed out in the patent uniformity in temperature and illuminating power of the lamps. Assuming that tar-putty is rolled out to the small size mentioned, less than one one hundreth of an inch, a small variation in its composition, in its diameter, in the spacing of the coils, in the rapidity and temperature of carbonization resulting 6018
in variations of resistance, would destroy the uniformity, the spacing of the coils having also the effect of varying the radiating surface. If the cotton thread or other material were carbonized in the coil form, the warping during carbonization would vary the distance apart of the coils if it did not contact the turns. If they were kept apart by insulating material, this would conduct more or less at high temperatures and destroy the uniformity. Furthermore, the influences ever present in such a lamp to lower the vacuum by evolution of gas from the joints would make these tendencies to irregularity still more decided, especially 6019
after the lamps were run. The condition of preparing the burners and attaching to the wires while in an uncarbonized state, is, in my opinion fatal to the lamp as a structure for commercial use; for the conditions are, as it were, set long before they should be, the lamp having to undergo the carbonization which results in great changes in the dimensions and constitution of the burner, after these conditions are set and cannot be changed. There is no element of variability or adjustment to make up for these changes at any point in the process; and in this re- 6020
spect I consider that the lamp was decidedly a move in the wrong direction from the other known incan-

6021 descent carbon lamps employing a strip of carbon whose dimensions could be adjusted in the best attainable vacuum.

11 Q. How essential to the subdivision of electric light on the plan indicated in the patent in suit, do you regard this uniformity of structure and of operation of the lamps?

A. It is the life of such a system. It is, indeed, the thing which must be attained before such a system can be made practically useful. The subdivision of the
6022 electric light contemplated is on the lines of gas distribution in which branches from the mains conveying current at a definite pressure, feed lamps in those branches singly, thus enabling each burner to be switched on or off independently of the others. There is one difference, however, from the gas distribution, and it is this: the element of variation is present with gas by turning on more or less to the burner, but with the electric lamp this element of variation is absent, the quality and amount of light depending, not upon the current supplied to each lamp alone, but upon the
6023 radiating surface and the temperature of such surface, and if this varies in the system with the different burners in use when the pressure on the mains is normal, it is a variation which is not within control. Hence the feature of uniformity, at least of radiating temperature or radiation per unit of surface of the burner, is essential. In order that any two lights may be of the same or standard candle-power under the same conditions, uniformity of extent or amount of radiating surface is required as well as uniformity in the vacua of the lamps. Indeed, one of the chief disadvantages of incandescent lighting even to-day after
6024 innumerable improvements, is that, after a certain number of hours of use, the lamps run down in respect to uniformity, losing in candle-power though they may

have been started at uniform standard. This deterio- 6025
ration, however, in well made lamps is slow, but may in some of them require replacement before they are actually broken. This simply shows the importance of uniformity as it relates to general distribution. A set of lamps in the same system which did not present a fair uniformity could not be operated commercially.

12 Q. State whether you have examined French Letters Patent No. 130,910 granted to Thomas Alva Edison May 28, 1879, and also Italian Letters Patent granted to Thomas Alva Edison June 23, 1879, No.
88 of Volume 22 of Register of Patents, as also U. S. 6026
Letters Patent No. 227,229, granted to Mr. Edison on his applications filed April 21, 1879.

A. I have.

The counsel for the plaintiff inquires whether these patents are referred to as anticipating the patent in suit or as illustrating the state of the art at the date of the patent in suit, as, if being the former, they would seem objectionable, not having been pleaded.

Defendant's counsel states that the patents 6027
are referred to for whatever value they may have in the case.

13 Q. State whether you find the invention which is patented in the last mentioned letters patent, also shown and described in the said French and Italian patents?

A. Yes, along with, in the French and Italian patents, quite a number of other matters.

14 Q. Which, in your opinion, would be the better 6028
adapted for commercial use, the lamp described in the said U. S. patent No. 227,229, as also in the said

6020 French and Italian patents, or the lamp shown and described in the patent in suit?

A. I find according to the statements in the patent 227,229 that it contemplates the use of a peculiarly treated platinum wire in a high vacuum, said platinum wire being attached to platinum leading-in wires sealed into the glass by melting; that the platinum wire is to be given a high resistance, as stated in lines 89 and 90 on first page of patent, namely, about 750 ohms when incandescent; that the lamp, as stated beginning with line 90 and continuing on page one to
6030 the bottom, also on page two down to line 27, is to be used in multiple arc with others in the same system; the advantage of such distribution with lamps of high resistance being clearly set out in the specification at the parts referred to, it being shown that by the use of high-resistance lamps a considerable number may be put in multiple-arc" without bringing the total resis- "tance of all the lamps to such a low point as to re- "quire a large main conductor", and that the radiating surface governs the amount of energy consumed irrespectively of the resistance.

6031 As I have not experimented with platinum lamps made in this way, I will refer for information regarding them to a paper communicated by Mr. Edison to the American Association for the Advancement of Science, and published in the proceedings of said association for the August meeting in 1879: an abstract of the same paper being found in the Telegraphic Journal and Electrical Review of London in its issue of October 1, 1879. In the said paper Mr. Edison describes the preparation of metalic wires, chiefly platinum and iridium, by gradual heating or successive heating *in vacuo*, and shows that the metal acquires new properties and can
6032 support without fusion a very high degree of incandescence, and says in said paper "that he has produced

"a metal in a state hitherto unknown and which is 6033
"absolutely stable at a temperature where nearly all "substances melt or are consumed. * * * When "wound in the form of a spiral it is as springy and "elastic when at the most dazzling incandescence as "when cold." He states that by this process he is able to get without fusion a light of 25 candles with a spiral which undoubtedly would have fused before it gave a light of 5 candles had it not been put through the process; or in another case a light of 8 candles from a spiral which would not have given more than one candle without melting. He says also, near the 6034
close of the paper:

> "I can now obtain 8 separate jets, each giving "out an abundantly steady light and each equal "to sixteen standard candles, or a total of 128 "standard candles, by the expenditure of 30,000 "foot pounds of energy or less than one horse "power."

I have no hesitation in saying that the platinum lamp here referred to, which is evidently that of patent No. 227,229, would be very much better than the 6035
lamp of the patent in suit for commercial purposes, assuming that the accounts above quoted are correct. If the platinum treated in the way mentioned is absolutely stable, as stated, during incandescence, it would have the great advantage over the lamp of the patent in suit in being able to be made of a definite high resistance, because the platinum wire could be cut to determinate lengths even after preparation: it would contain in itself the elements of variability; being like other metallic wires, it can be drawn to a definite diameter, and with a definite length would be expected to be rendered uniform with other 6036
lamps in the same system. If, as this patent states, it could be given a resistance of 750 ohms

6037 when incandescent, which is a very high resistance, it would require a very small current flowing to render it incandescent, and would be very well adapted to distribution in multiple-arc with small mains.

15 Q. Please say whether, in your opinion, it would have involved invention, in June or July of 1879, for a person familiar with the laws of electricity and also familiar with the lamp shown and described in the Edison patent 227,229, and in the corresponding French and Italian patents of May and June, 1879,
6038 to substitute in the all-glass, exhausted globe of that lamp a carbon burner in place of the platinum burner which said patent described as actually used; assuming, if you please, that such person would have known how to make a carbon burner sufficiently small and how to attach such burner to the leading-in wires?

A. It would not, in my opinion, have involved invention at the time stated, or even many years before that time, to have substituted carbon for platinum, as a resistant material of an electric lamp operating by incandescence.

6039 I am confirmed in this opinion by the fact that carbon was a well known substitute for platinum as an incandescent substance in any electric lamp; that the two substances were frequently mentioned together as substitutes in prior patents and descriptions; that in the prior art it was perfectly well understood how to adapt resistant materials, such as carbon or platinum or other metals, to convey currents of definite volume under definite electromotive forces, while producing incandescence of those materials. It was known that carbon had a comparatively much greater
6040 resistances for the same dimensions than platinum. It was known that it was capable of resisting high temperature without fusion or evaporation when oxygen was excluded. It was known that to use any re-

sistant material in an electric circuit, with a definite 6041
current and definite electromotive force or current, while producing incandescence of a resistant conductor, there was needed to select such a diameter or section in relation to the current passing, as would cause heating to the desired temperature, and such a length as would be required to use up the pressure, or more exactly, to cause the pressure of the current or electromotive force to be insufficient to more than pass the current mentioned as needed to produce the heating.

This adaptation of length and section of resistant 6042
conductors had been performed hundreds of times by myself and others working in the electric field or teaching the principles of electrical science, and was a commonly described operation in the books long prior to the time stated. It was an operation constantly performed in actual practice with electric fuses worked in series or in multiple-arc. These fuses consisted oftentimes of small resistances of fine metallic wire, sometimes platinum, sometimes of carbonaceous paste or strips of comparatively bad conductors, and were adapted to the current and electromotive force operating them by bringing them to incandescence, as in fir- 6043
ing gunpowder charges, by selecting wire or resistant material of such length and such section relatively to the electromotive force and current at command as to secure the ignition of the fuses.

I have frequently, in working with voltaic batteries prior to and after 1870, and with dynamo-electric machines from 1874 and 1875 and thereafter, had occasion to select such lengths and sections of resistance wires and conductors, including carbon, platinum iron and the like, as would adapt them to be brought to incandescence by the electromotive force and current 6044
at command. I have frequently worked with batteries used for exploding gases in eudiometers in which it was requisite to select for the fuse or spiral

6045 just that length and section that would be brought to a limited incandescence by the battery at command. In general the operation of adapting length and section of any resisting material to conditions of limited current and electromotive force, both for incandescence and utilization of energy in other ways, has been one of the oldest and best known procedures in the electric arts; and this is true, not only for the same material as platinum, but where different materials of different conducting power were to be substituted one for the other. It had been perfectly well known for many
6046 years, prior to 1879, that with conductors of different specific resistance brought to incandescence, the higher the specific resistence with a given current the larger the section required and conversely, and that the higher the specific resistance the shorter the length with the same section and current with a given electromotive force. It had also been perfectly well known that when we have a fairly good conductor brought to incandescence by a given current and electromotive force, said conductor having a certain diameter and length, a poorer conductor would re-
6047 quire, under the same conditions—that is, with the same current and electromotive force—a lessened length and greater section. This assumes equal freedom for radiation and dissipation of heat in both cases. It had been perfectly well known also, long prior to 1879, that the coiling or restriction of radiation of the resistant material would increase its temperature and therefore modify the relations just pointed out above. It was also known that in air or gases a vertical conductor heated by the current was far more readily brought to incandescence, that is, required less current than dispositions in an inclined direction allow-
6048 ing freer removal of heat by convection into the air.

In view of these and other facts I cannot regard the substitution of carbon for platinum in the lamps in question as in any wise different from, or involving

any more invention than in former lamps where the 6049
substitution was well understood, or than in the various adaptations well known in the electric arts many years prior to the date of the patent in suit.

16 Q. Please state whether you find described in the Edison patent in suit, any new process for manufacturing carbon burners for incandescent lamps?

A. I do not, unless the omission of certain steps which were resorted to in the prior art in making carbon burners constitute this novelty. I find that the making of carbon burners by what may be called
the tar-putty method, was old at the date of the pa- 6050
tent in suit; that the carbonization of fibrous materials, with or without tar-putty or plastic composition intermixed, was old for producing carbon articles of various kinds; that it was not new to incorporate fibrous materials with plastic carbon compositions, and coil the same into spiral shape for electric light carbons. I refer to Letters Patent to Gauduin, No. 113,706 [French patent], under date of Sept. 16, 1876, and the certificate of addition thereto of April 7, 1877.

The process of Gauduin described is directed to the 6051
production of carbon articles, vessels, rods, etc., for various purposes, including, as mentioned, "the pencils intended for the production of electric lights." He goes on to describe the necessity of purity in his manufactured articles, and states that soot is a sufficiently pure material for his purposes, soot being evidently intended to indicate lampblack; he mixes his materials in the finely pulverized state with the tars or hydrocarbon products of distillation, so as to be able to shape the articles, as by the *filiere* or draw-
plate process, in the manufacture of pencils of carbon, 6052
and carbonizes the same in close vessels. This is evidently the same, or a closely similar process to the tar-putty process of the patent in suit. In the certifi-

6053 cate of addition he describes certain improvements in his processes. He says:

> "I form the crucibles, vessels, pencils for "electric lighting, or for electro-chemistry, etc., "with dry wood suitably selected, by all the "methods proper to working in wood. I con- "vert this wooden object into a hard and com- "pact carbon, conserving its primitive form by "drying it suitably, impregnating it with tar, "pitch, bitumen, rosin, essences and oils of coal,
> 6054 "any carbide of hydrogen, sugar, caramel, or "other matter possessing analagous properties."

After which he heats slowly and then carbonizes at a high temperature in a reductive atmosphere. He says besides:

> "I also manufacture articles of carbon from "cotton, hemp, flax, cellulose in any state, "kneaded and impregnated with pitch, tar, etc., "and formed so as to give it the desired shape. "I finish them as if the object were of impreg-
> 6055 "nated wood."

Gauduin used a process for increasing the density of his carbon articles by impregnating them with carbonizable material. Long prior to this patent it had, of course, been perfectly understood that the carbonization of vegetable materials, such as wood, cotton, thread or fabric, gave as a result carbon maintaining nearly the original shape and fibrous character. Gauduin took the art as he found it, and with such materials produced denser carbons by impregnation as
6056 described. M. Gauduin's process is also described on page 46 and following pages of Fontaine's Electric Lighting, edited by Paget Higgs and published in 1878.

In regard to the process of rolling to give form to 6057
the paste or putty before carbonization, I find that this method is mentioned in a provisional specification of Great Britain, No. 861 of 1878, to Thos. Francis Scott. The invention relates, as the specification states, to improvements in the manufacture of rods sticks, blocks and discs and hollow cylinders of carbon to be used in the production of light by electricity. He uses finely powdered carbon of various kinds, and makes it plastic with flour paste or starch paste; he either forces the mass through a draw-plate, or, as he says, "they may be made, when cylindrical
"in figure, by rolling portions of the plastic mass on a 6058
"flat surface or by the action of grooved rolls." He then dries and carbonizes the articles at a high temperature. He says further, that his invention consists, secondly, in manufacturing flexible bands, ribbons or cords of carbon to be used in the production of light by electricity. In this case he takes the carbon or carbon mixture, and incorporates therewith fibres o asbestos or fibres of hemp, or other mineral or organic fibres together with adhesive matter. He then says, "by rolling or otherwise, I form the mixture into long
"bands, strips or ribbons, and dry them by heat." In 6059
this case, however, he designs that the fibres, if organic, shall not be carbonized, but shall remain in their original condition.

The oldest of the methods of producing carbons for arc lights, which are described briefly in Fontaine's Electric Lighting before referred to, Chap. 3, concern the production of a plastic paste from carbon in he form of impalpable powder and a carbonizable material such as syrup or tar, and afterwards molding the articles to shape and carbonizing them. In others,
impregnated organic material was carbonized and 6060
sometimes subsequently soaked for a second or third time in carbonaceous material and carbonized after each soaking.

6061 The well known process by which Carré carbons are produced is also described, pages 42, 43 and 44, consisting in producing a paste or putty of fine carbon and plastic binding material, shaping or moulding the same, carbonizing and subsequently impregnating with carbonaceous materials and again carbonizing. The carbons so made were used in arc-lighting and incandescent lighting by electricity.

In the British patent of Pulvermacher, No. 4774 of 1878, there is described a sort of modified Jablochkoff candle in which a carbon spiral is used as one of the
6062 elements. This patent illustrates the process of making such forms in carbon and refers to the construction of what the inventor terms his "rod spiral" as follows:

> "The central portion of this rod consists of "a thinner rod composed of a paste or compound "of fine powdered pure charcoal mixed with tar "and pitch or by compression of lamp-black and "obtained by pressure through a draw plate."

The word "thinner" in this quotation ought evi-
6063 dently to be "thicker". He continues:

> "The surrounding or enveloping part consists "of a thinner carbon rod or thread, also ob-"tained by pressure through a draw-plate. This "thin rod is provided in the course of manu-"facturing with a central textile thread forming "a kind of core and giving strength to the car-"bon."

He goes on to state that this rod or thread is wound in spiral coils around the before-mentioned inner rod, insulating material having been placed around the
6064 central rod beforehand. He goes on to describe the placing of the rod-spiral, as he terms the structure, in a box filled with powdered or pulverized carbon for

the baking operation, which baking operation is, of 6065
course, the carbonization by heat.

It will be seen from these references that the forming of carbon pastes, and the carbonization of organic materials, impregnated or not, were well known ways of producing carbons in various forms. I might mention also that graphite, a form of carbon, has in like manner been cemented and molded in form for obtaining rods as in pencil making.

In answering this question, I have left out of consideration, as relates to the patent referred to, the
forming of the joints with the platinum wires prior to 6066
carbonization, along with the forming of the carbon spiral itself before carbonization. I think this may be new in the formation of carbon burners; but so far as the making of a carbon conductor is concerned, the processes do not, broadly considered, differ from those well known in the art, unless, as I have stated, the omission of certain steps, resorted to in some of the processes for increasing the density of the carbon, may be considered novel. I refer especially to the absence of any soaking or impregnating process in the Edison patent referred to, such impregnating process being
means for increasing the rigidity and density of a 6067
carbon rod or pencil.

Adjourned to February 6th, 1890.

BOSTON, MASS., FEBRUARY 6th, 1890.

Met pursuant to adjournment.

Present counsel as before.

Examination of the witness THOMSON continued. 6068

17 Q. State whether any instructions contained in

6069 the Edison patent in suit would enable a person
skilled in the art, at the date of said patent, to make
carbon burners for incandescent lamps of smaller
cross-section than would be possible with the processes of manufacture known to the art prior to said date?

A. No, I think not. I have already stated that the processes are the same in Edison's patent as those known to the prior art of making carbons, and, so far as small size goes, it is a matter of manipulation or delicacy of handling in either case.

6070

18 Q. Do you agree with the statement made by Professor Barker in answer to question 6, that, at once upon the appearance of the patent in suit, it was generally recognized that Mr. Edison had solved the problem of the practical subdivision of the electric light, and had produced a lamp possessing the indispensable requisites of high economy, durability and simplicity of construction?

A. I do not agree with Professor Barker in this
statement. I do not think that the appearance of
the patent in suit had any such recognition: and,
6071 further, I do not see how it could, since
no exhibition of lamps made in accordance
therewith was to be seen; and I do not
see how it could have been recognized that the indis-
pensible requisites of high economy, durability and
simplicity of construction existed when nothing was
known of the lamp described. I think, on the other
hand, that the publications of Mr. Edison with re-
spect to his platinum lamp, particularly his paper be-
fore the American Association for the Advancement
of Science, was more calculated by far to produce
6072 the effects mentioned by Professor Barker, and did
produce such effect, assuming that the results were
accurate and could be substantiated.

I may mention in this connection that the announcements that Mr. Edison had subdivided the electric light were made at least a year earlier, and had an

effect in causing a heavy drop in gas shares, and the 6073
light must have been something entirely different
even from a platinum lamp or a carbon lamp. I re-
fer to the Telegraphic Journal of October 15, 1878.
On pages 413, 414 and 415 we have a statement with
remarks upon the announcement of subdivision. I
quote from page 414, second column near the middle,
in which it is said of Mr. Edison: "On Friday, Octo-
"ber 4, his efforts were crowned with success, and the
"project that has filled the minds of many scientific
"men for years was developed. 'I have it now', he
"said, on Saturday, while vigorously turning the han- 6074
"dle of a Ritchie induction coil at his laboratory at
"Menlo Park,' and singularly enough, I have obtained
"it through an entirely different process than that
"from which scientific men have ever sought to secure
"it. * * * With the process I have just discovered
"I can produce 1,000—aye, 10,000—from one machine.
"Indeed, the member may be said to be infinite. When
"the brilliancy and cheapness of the lights are made
"known to the public—which will be in a few weeks,
"or just as soon as I can thoroughly protect the pro-
"cess—illumination by carburetted hydrogen gas will
"be discarded. With 15 or 20 of these dynamo elec- 6075
"tric machines recently perfected by Mr. Wallace, I
"can light the entire lower part of New York City,
"using a 500 horse power engine."

The use of a Ritchie induction coil forbids the idea of incandescent platinum or carbon, as also does the statement that the entire lower part of New York City could be lighted by a 500 horse power engine.

The term "subdivision of the electric light" I have
never understood to mean anything in this connection.
The problem was never assuming an electric light as a 6076
thing to be cut up or subdivided, but rather the delivery
of electric energy to produce a number of lights. It

6077 was rather a mutiplication than a subdivision. It is true that large, intense arc-lights were known, the subdivision of which, without loss of illuminating power, would have been and still is a great desideratum. That Mr. Edison in his patent in suit, or anybody else, or in any other patent, has shown a feasible means of subdividing *the electric light* without loss or lessened economy in the production of the light, is certainly not in accordance with fact; indeed, if the question of economy of lighting is considered, the incandescent light of to-day with all improvements and refinements
6078 can hardly be said to be economical as compared with gas. Its ability to compete with gas to-day is largely due to improvements in the economical production of power, besides great strides in distribution of current and perfection of the lamp itself.

19 Q. Do you agree with Prof. Barker, in his further statement in answer 6, that upon the issue of the patent in suit capital began to embark in various projects for the illumination of cities and towns by electricity in place of gas, which the new invention rendered possible?

6079 A. I do not agree that upon the issue of the patent in suit capital so began to embark; but I know that on the contrary it was a long time subsequent to the year 1880, that much progress in such projects was made. It is true that prior to the issue of the patent in suit attention had been directed to the supply of arc lights from central stations. This was notably the case in Paris in 1878, where the Jablockoff candle system was put into operation for lighting some of the parks and boulevards. The introduction of the Jablockoff system led to considerable activity in arc
6080 lighting and arc-light manufacture, with projects for central stations supplying arc lights in some of the larger cities. Referring

to the Eleventh Bulletin of the Edison Electric Light Company, dated June 27, 1882, at page 3, it 6081
would seem that the manufacture of lamps by the company was commenced at Menlo Park in November, 1880, as a regular manufacture, though prior to that time a large number of lamps had been made; so it is stated. The lamp factory was moved to Newark about April, 1882. It was not, I believe, until later in the year 1882 that the first central-station plant was begun by the Edison company, an account of which is found in the Fourteenth Bulletin of the Edison Company, on the first page, the plant having been started 6082
as there stated in September, 1882. Even after this, as my recollection serves me, the embarkation of capital in central-station enterprises for incandescent lighting was very slow, though a large amount of capital had meanwhile gone into the construction and working of central-station, arc-light plants.

20 Q. Do you then agree with Professor Barker in his further statement, contained in his answer 6, that upon the grant of the patent in suit central stations were rapidly introduced both in this country and in Europe, and that lamps constructed substantially according to the principles of the patented invention came into extensive use immediately after the issue of said patent and in enormous numbers? 6083

A. I do not see that the issue of the patent had any such effect or that it was accompanied by any such events as stated by Professor Barker. Indeed, as I have stated in my former answer, the Edison Bulletins show that the first stations were two or three years later than, or subsequent to, the issue of the patent. The first station was the New York station established and put in operation in the Fall of 1882, as appears in 6084
the second paragraph of Mr. Edison's answer to Q. 486, pages 288, 289, of his testimony given in the McKees-

6085 port suit. On referring to Bulletin 20, pages 42, 43, I find that it was not until October 17, 1883, or a year after its establishment, that the number of lamps wired for supply exceeded two-thirds of its capacity as originally laid out. Other central stations subsequent to this were, if I remember rightly, established in Brockton and Lawrence, Mass., I think in the year 1883; so that it will be seen that Professor Barker is not quite correct in saying that immediately after the issue of the patent the lamps came into extensive use in enormous numbers so far as central-station plants
6086 are concerned. And I find further that the lamp factory at Newark was not established until near the middle of 1882.

Referring to Bulletin Eleven, page 3, I find the statement that up to April 1, 1882, 80,000 lamps were shipped, and there were about 50,000 unsold in stock. In the Sixteenth Bulletin, issued February 2, 1883, I find a summary on page 30 of the lamps installed in foreign countries which is said to number 19,536; while on page 27 I find that up to December 20, 1882, plants aggregating 29,192 lamps had been established in the United States.

6087

21 Q. Professor Barker, in answer to Q 6, has also expressed the opinion that the invention in the patent in suit was "practically the creation of a new art in lighting by electricity." What is your opinion upon this point?

A. The production of light by incandescence was well known prior to the date of the patent in suit. I cannot agree with Professor Barker that this invention or lamp was the creation of a new art.

I have before pointed out my reasons why I think
6088 the lamp could not be made as described in the patent in suit and used commercially. The development of the art of commercial incandescent lighting depended

upon, and was consequent upon, a large number of im- 6089
provements in dynamos, in methods of distribution, and regulation, and in many improvements in incandescent lamps themselves, and in methods for constructing them. In fact Mr. Edison states, in answer to Q. 485 in his testimony in the McKeesport suit, that tha problem was the production of multifarious apparatus, methods and devices. I quote from his answer beginning folio 1140, page 285 and ending folio 1148, page 287 at bottom, as follows:

"The problem then that I undertook to solve 6090
"was, stated generally, the production of the "multifarious apparatus, methods and devices, "each adapted for use with every other, and all "forming a comprehensive system whereby "electricity, properly controlled and directed, "could be distributed over large areas through "the streets of a city, and supplied to houses in which it would feed incandescent electric lamps of moderate candle power, which would be entirely under the control of the householder, the whole to be on the same scale as the pre- 6091
sent system of gas distribution and affording the same character of convenience to the users.

"The first thing necessary to be done was to adopt a fundamentally correct system of distributing the electric current and then to devise a lamp which could be worked practically on such a system that would be practical and satisfactory both in a commercial and scientific sense. The essentials of a comprehensive system of electric illumination, similar to the general plan of illumination by gas, were a net- 6092
work of conductors all connected together so that in a city area the lights could be fed with electricity from several directions, thus elimin-

6093 ating the disturbances to any particular section.

"SECOND. To devise an electric lamp which would give about the same amount of light as the gas jet, which custom had proved was a suitable and useful unit, and which should possess the qualities necessitated by small investment in the copper conductors. It was also necessary that each lamp should be independent of every other lamp, although on the same circuit. That the light should be produced
6094 sufficiently economically to commercially compete with gas. That the lamp should be durable, and capable of being handled by the public, and cheap to manufacture, and one that would remain incandescent and stable a great length of time.

"THIRD. It was also necessary to devise means whereby the amount of light furnished a consumer could be accurately determined, as in the case of a gas-meter, and that this should
6095 be done cheaply and reliably.

"FOURTH. I had also to devise a system of conductors capable of being placed underground or overhead, and which would allow of being tapped at intervals, speaking generally, about the width of each house facing the street, so that service wires could be run from the main conductor into each house, as gas pipes run from gas mains, and generally whatever was necessary to such a comprehensive system of distribution as the system I had in view required.
6096 Where the conductors were to be placed underground, which I contemplated doing in large cities, it was necessary to devise a system of protective pipes for the copper con-

ductors, which would allow of their being tapped wherever required; also man-holes, junction boxes, connections, and the various paraphernalia of a complete system for underground general distribution. 6097

"FIFTH: I had also to devise means of producing at all points, and on an extended area of distribution, a practically even pressure analogous to gas, so that all of the lights should give an equal light at all times and independent of the number that might be in use. I had also to devise means for regulating, at the point where the current was generated, the equality 6098
of the pressure of the current throughout the whole lighting area, also a means of indicating what the pressure was at the various points of the area.

"SIXTH: I had also to devise economical dynamo machines for the conversion of steam power into electricity, means for connecting, disconnecting, working and regulating the same: means for equalizing their loads; means for regulating the number of machines to be used to 6099
the demands on the station for electricity from the users of the light. The arranging of complete stations, with steam power and electric apparatus, and devices of all kinds to suit the varying conditions of buildings available for such stations in cities.

"SEVENTH: I had also to devise devices which would prevent the current used from becoming excessive upon any conductors and causing fire or other injury, switches whereby the current could be turned on or off at such points as it 6100
was desirable that this should be done, lamp holders, electric chandeliers and the like. I

6101 had also to devise means and methods for placing the wires that were to convey the current to the chandeliers in buildings."

It will be seen that a vast amount of work by different inventors, has made the art of incandescent lighting what it is to-day; that such work was necessary to be done before a new art could be created. Mr. Edison found that the art grew slowly on account of the multifarious improvements required. I can see no difference in respect of creating a new art
6102 between the patent in suit and other patents or inventions such as the platinum burner, which, as Mr. Edison sets out, had a high resistance adapting it to be used in multiple arc on mains of moderate dimensions and at some distance away from the source of current or energy.

The position here taken is borne out by statements found in the Twenty-first Bulletin of the Edison Electric Light Company, pages 59, 60, 61, which I quote as follows:

"But it must be remembered that even if Mr.
6103 Swan's patents were for a lamp instead of for a few details of one, and even if those details were important, his patents would still amount to nothing unless he had also invented and patented a comprehensive system of using them. In this respect Mr. Swan has nothing. He has no patents whatever on any system or on any of the almost innumerable details needed in a lighting system, involving regulation, distribution, measurement, conductors, safety-catches, meters, chandeliers, brackets, drop-
6104 lights, etc., nor do the Swan patents confer any right on him to use any such things, or even to make a lamp. The slightest use of what

he alleges to be his inventions involves in- 6105
fringement of underlying patents granted to another. All these details of the necessary parts of a system of incandescent lighting have been elaborated and patented by Mr. Edison. It is impossible to make or introduce an incandescent lamp without them.

"In this connection a concise statement should be made of Mr. Edison's patents, including his fundamental patents on an electric lamp, his patents on methods of manufacturing a lamp
and mechanical details, together with his large 6106
number of patents on the important details of a system of incandescent lighting. The fundamental patents which give Edison a monoply of the incandescent lamp, are as follows: namely, No. 223,898, dated January 27th, 1880; No. 227,229, dated May 4th, 1880; and No. 230,255, dated July 20th, 1880. Besides these, Mr Edison holds 83 other patents already granted in this country on the lamp alone, and has applications for 75 more patents on the
lamp alone now awaiting decision. In these 6107
patents, and especially in the first three above named, the following points are broadly covered to Mr. Edison.

"1. An electric lamp having a continuous conductor (without regard to its material, resistance or mode of preparation) and an exhausted glass enclosing globe.

"2. An electric lamp having a continuous carbon conductor (irrespective of its material,
resistance or mode of preparation) and an ex- 6108
hausted glass enclosing globe.

"3. A filament of carbon of high resistance

6109 secured to metallic conductors (i. e., the leading-in wires.)

"4. The method of manufacture, i. e., first, separately forming the enclosing globe and the support for the carbon, and then affixing the carbon upon the latter, uniting the globe and support and then exhausting.

"The broad principles covered in the above-named fundamental patents allowed to Mr. Edison are so exclusive that it is not too much to
6110 say that neither Swan nor anyone else has made or can make a successful incandescent lamp without infringing every one of the above patents.

"But these patents allowed to Mr. Edison on his lamp are only a small portion of the patents allowed to him in connection with the use of the lamp. Up to the present time no less than 227 patents have been allowed Mr. Edison, in the United States alone, on his lamp and on the details connected with its manufacture and use,
6111 and he also has 179 additional applications for patents on the same subject now awaiting examination at the Patent Office. These patents cover such subjects as the lamp, regulators, dynamos, meters, motors, conductors, underground mains, junction boxes, sockets, chandeliers, brackets, and many other devices, altogether constituting a complete and perfect *system* of electric lighting."

22 Q. What do you understand to be meant by the words "practical sub-division of, the electric light,"
6112 found in the patent in suit?

A. I understand the words to mean that electric energy is to be generated at a certain place and dis-

tributed over a considerable area, and to various 6113
points very much as gas is distributed through mains and branches, whereby each consumer may obtain a light of moderate power resembling in intensity that obtained from a gas jet; that this distribution is to be accomplished with economy in the transference of the energy to distances making the system comparable with a gas plant in a town or city. There are other details which might be assumed to belong to such a system, as, for example, the independent control of lighting and extinguishing of the separate units of light; the maintaining on the mains of a pressure of 6114
current such that the lights or lamps in the system would be kept of uniform or standard brilliancy.

The expression, "subdivision of the electric light," would, I think, also involve the idea that practically it must be accomplished with not too great outlay for plant such as would be prohibitory in a commercial sense. This involves the multiple-arc distribution such as is referred to, where a comparatively heavy set of mains are branched to the individual lights of the system, and where those mains are not to be excessive in size or too expensive on account of the amount of copper involved in their construction. 6115

23 Q. If, prior to the date of the application for the patent in suit, a person skilled in the art had undertaken the distribution of electric light in multiple arc with the old incandescent lamps referred to in the patent, and had found that with a large number of such lamps main conductors of enormous dimensions would have been required, would he have known what changes, if any, would have had to be made in the lamps to obviate that difficulty?

A. I think without question he would. The same 6116
proceeding was perfectly well known in relation to other electrical devices; that is, that where a device

6117 of low resistance comparatively was in one case oper-
ated near the source of current and in another case at
a distance therefrom, it was known that with a given
sized conductor there would be more loss in the trans-
mission the greater the distance, and that to save this
loss it was only necessary to give the device using the
current a high resistance as compared with the line.
This was done in telegraphy, when relays were used on
long lines of many miles, and which, in consequence,
instead of being wound with course, low-resistance
coils were wound with fine, high-resistance coils of
6118 many turns.

It was also known in relation to the explosion of
mines in blasting, or such work, by electric fuses. A
fuse which could be operated at a distance of 20 or
30 feet over a good sized wire, because sufficient cur-
rent could thereby be supplied to heat it, might fail
to be operative without too great loss on the lines if
the wires were extended two or three hundred feet.
In such case, the fuse itself would be made of high
resistance comparatively, so as to take less current
and more electromotive force to work it. More cells
6119 of battery coupled for increased etectromotive force
would in this case, be used.

In my opinion, therefore, there would have been
not the slightest difficulty in pointing out what should
be done in the case mentioned in the question, where
an attempt to run comparatively low-resistance lamps
is assumed under the conditions stated. I am, indeed,
sure that electric science and the electric arts had ad-
vanced prior to the issue of the patent in suit so as to
make it perfectly evident that the thing to be done
in order to reduce the size and cost of the mains
and prevent undue loss of energy in them, was to put
6120 more resistance into the burner.

24 Q. Suppose a set of lamps (20 if you please) ar-

ranged in the neighborhood of a dynamo, and fed by 6121
wires of such size as to cause by their resistance only
a small percentage of loss of the energy of the cur-
rent; what would be the effect on the size of the con-
ductors of removing such lamps to a much greater dis-
tance, say ten times the distance, from the dynamo,
the percentage of loss by the resistance of the wires
remaining the same?

A. The effect would be to increase the size of the
conductors greatly. In the case assumed, the distance
having been increased ten times, the conductors would
require to be increased in section ten times, so that
the length might be increased without involving an 6122
increased resistance or loss in the conductors. This
would make it necessary to use, in the case of the
greater distance, ten times the length with ten times
the section, or one hundred times the amount of metal,
such as copper, in the conductors; and these require-
ments would be the same whether the lamps, say 20,
were used in series in a group, or in multiple arc in a
group, or in other arrangements, provided, of course,
the arrangement adopted is the same in the two
locations.

6123

25 Q. Please state whether by modifying the con-
struction of the lamps supposed in the last question,
this difference in the size of the conductors in the two
cases could be obviated, and if so, how; and would
this problem be the same with reference to series
lamps as to multiple-arc lamps?

A. It could be obviated by increasing the resis-
tance of the lamps; assuming, of course, that it was
practicable to so construct them. I make this assump-
tion because there might come into play other influ-
ences preventing the necessary increase of resistance 6124
from being attained. Thus, if the lamps were con-
structed of a fine coil of platinum rendered incandes-

6125 cent, it might not be possible to draw down the wire to a size so small as to secure the increased resistance required. This depends altogether on what we start out with. I do not see that there would be any difference introduced whether the arrangement of the lamps at a distant point was a series one or multiple arc. The transfer of the energy on the line is the question in each case, and if the distance is great and it is desired to keep down the size of the conductors, a small current must be used; but as the energy is always the product of the current by its
6126 pressure or electromotive force, it will be seen that in reducing the current we must increase the electromotive force necessary to pass the current through the lamps. This latter condition is met by increasing the resistance of the lamps, either taken single or as a whole, for the conditions are not any different whether one lamp or 20 be used and fed at points different distances away from the source of current; except that, of course, if a single lamp be used at one point or another of distance, the current and electromotive force is determined by that single lamp irrespective of any arrangement of series or multiple
6127 arc.

26 Q. Do you find in the patent in suit any indication of the minimum resistance permissible in a lamp embodying the invention to which the patent relates?

A. There is little direct indication; but the patent is specific in certain senses, the statement made in the second paragraph of the patent being,

> "The object of this invention is to produce "electric lamps giving light by incandescence,
> 6128 "which lamps shall have high resistance so as "to allow of the practical subdivision of the "electric light."

The statement is also made in the sixth paragraph 6129
as follows:

> "Heretofore light by incandescence has been "obtained from rods of carbon or from 1 to 4 "ohms resistance placed in closed vessels," &c.

And further on the statement is made that the former attempts were to reduce the resistance of the carbon rod, after which it says,—

> "The disadvantages of following this practice 6130
> "are that the lamp having but one to four ohms "resistance cannot be worked in great numbers "in multiple arc without the employment of "main conductors of enormous dimensions, that "owing to the low resistance of the lamp, the "leading wires must be of large dimensions and "good conductors, and a closed glass globe can-"not be kept tight at the place where they pass "in and are cemented; hence the carbon is con-"sumed because there must be almost a perfect "vacuum to render the carbon stable, especially
> "when such carbon is small in mass and high in 6131
> "electrical resistance"

These statements point to the fact that the lamp was intended to be of such resistance that it could be practically and economically used in solving the problem of a subdivision, which, as I have before pointed out, and which Mr. Edison in his answer to question 485 in the McKeesport suit, in the paragraph included between folios 1140 and 1142 of the printed record, and in other parts of the same answer, has
stated to be a system comparable to that of gas dis- 6132
tribution in which the mains supply the lamps in branches from the mains in the manner of gas jets within the control of the consumer for turning on

6133 and off. The pressure is maintained in the mains sufficient to overcome the resistance of the lamps and at the same time not involve losses in the mains and not involve excessive size in the mains such as would make the cost of laying them prohibitory. It was well understood that in such a system of distribution as is here contemplated, the resistance of the lamps taken as a whole must be very much greater than the resistance of the mains taken as a whole, or the conditions of economy could not be fulfilled. Now, if the resistance of the lamps be comparatively low, the re-
6134 sistance of the mains will have to be correspondingly much lower, and if this corresponding reduction of resistance involves an enormous cost or enormous size of conductors in conveying the energy over moderate distances, it is evident that the lamps themselves require to be made higher in resistance so that the mains may be reduced to within a cost which is not prohibitory and which may be commercially used. An important factor in this case is, that if, with a given resistance of lamps taking a certain current, we have secured a certain section of copper in the conductors, then, if
6135 the resistance of the lamps be so lowered in the system as to require twice the current, the amount of copper required for the mains would be four times as great, since the loss of energy in a resistance varies not as the current but as its square; hence the importance of keeping down the current flowing to the lamps in a multiple-arc distribution from a central station and supplying the energy to the lamps with electro-motive forces sufficiently great to pass this moderate current over the resistance of the lamps, either taken together or singly. Such a system of
6136 distribution as is here contemplated requires that practically the mains should contain such an amount of copper as would permit each lamp individually to

be run as though by a single outgoing and return wire 6137
connected through each lamp and to the source of the current. A small increase of distance in such a system means a great addition, as above pointed out, to the copper required in the mains. Moreover, it is also requisite in the system that the loss by resistance in the mains shall not be a large proportion, as otherwise the lamps cannot be turned off or extinguished in part without affecting the brilliancy of the remainder. This is particularly true where, as contemplated, the lamps supplied will be at varying distances from the source of current. In other words, the pressure 6138
or electro-motive force of the current must be substantially uniform whether all or a part of the lights are in use, and this again forbids the use of too small conductors.

Now if the patent in suit may be assumed to give indications of what this resistance is to be, for a lamp of ordinary candle-power, such as 16 candles—replacing the gas jet,—I think it is to be found in accordance with the considerations just pointed out and in accordance with the statements of resistance given in the paragraph of the patent beginning on line 60 and ending line 97, page 1. The specification 6139
says:

> "I have discovered that even a cotton thread "properly carbonized and placed in a sealed "glass globe exhausted to one-millionth of an "atmosphere, offers from 100 to 500 ohms re-"sistance to the passage of the current, and "that it is absolutely stable at very high tem-"peratures; that if the thread be coiled as a "spiral and carbonized, or if any fibrous vegeta-"ble substance which will leave a carbon 6140
> "residue after heating in a closed chamber be "so coiled, as much as 2,000 ohms resistance

6141 "may be obtained without presenting a radiat-
"ing surface greater than 3-16th of an inch."

Here it would seem that the minimum indication of resistance given is 100 ohms in the lamp during operation, and that 2,000 ohms is considered as a high limit; and the fact that distribution from central stations in the manner contemplated requires for economy a resistance considerably higher than 100 ohms to avoid the use of enormous main conductors, is confirmatory of the meaning here pointed out. In
6142 fact, notwithstanding that lamps are made and used and have been for a number of years, of about 150 to 200 ohms for a light of 16 candles, it is very doubtful indeed whether any considerable growth or extension of such a system as is here contemplated would have occurred without subsequent inventions being put into use specially directed to the saving of copper in the conductors. The plain multiple-arc system, in fact, in which the lamps are branched from the mains is to-day limited as to the distance it can cover with lamps of the highest attainable resistance, to points within very moderate areas around the central station; and
6143 even with improvements which have reduced the copper needed over 60 per cent., the amount of copper still required for the supply conductors limits their extension to distances which are yet quite moderate and in no way comparable to the extension which can be made to the gas mains or pipes over the area of a city. Even with, I say, the highest attainable resistance in the lamps which has been found practicable, the establishment of central stations at different points over the territory of a large city has been found necessary by the Edison company in order that the conductors
6144 of the system shall not be prohibitory in expense in reaching the farther lamps from the station. It is certainly true that with lamps of 100 ohms or less, a system laid out for supplying them in multiple-arc

could not be made to fulfill the purposes of subdivision 6145
of the electric light as contemplated in the patent and as pointed out by Mr. Edison to have been his object, without the employment of enormously large main conductors absolutely prohibitory in their first cost.

It is here to be considered that it is not alone a question of large main conductors, but that the enlargement of the conductor means enlargement of its insulating covering, of its receptacle, of the contact surfaces and size of the switches used, and in general a scaling up of the proportions of all the parts of the system concerned in the transfer of current. 6146

25¼ Q. Are the resistances of defendant's zig-zag paper lamp and defendant's M lamp in evidence, in your opinion sufficiently high to allow of the practical subdivision of the electric light as referred to in the patent in suit, making use only of those methods of electrical distribution which were known to the art at the date of the patent?

A. Understanding that the resistance of the zig-zag lamp in operation would be about 79 or 80 ohms and that the resistance of the M lamp referred to would be
about 40 ohms, I would say such lamps would not be 6147
adaptable to subdivision of electric light in accordance with the conditions of the question; that is, assuming that no use is made of any methods of electric distribution other than those known and used in the art at the date of the patent in suit.

Adjourned to February 7th, 1890.

Boston, Mass., Feb. 7, 1890. 6148

Met pursuant to adjournment.

Present, counsel as before.

6149 Examination of the witness Thomson continued.

26½ Q. What is the meaning of the term "wire" as used in the arts and especially in the electric arts?

A. The term "wire" in the electric arts and in other arts is applied to a length of metal, generally, which can be coiled and which is of round section, though square and rectangular sections also come under the same designation. There are wires used in the electric arts which range from the finest that can be made, probably as low as a thousandth of an inch
6150 or less in diameter, up to sizes which approximate half an inch in diameter.

27 Q. Please state whether in trade or shop nomenclature the two terms "wire" and "rod" import any difference as to area of cross-section in the articles to which these terms are respectively applied?

A. I do not think that they do; the term "wire" being frequently applied when the rod is in the form of a coil, and the term "rod" being often used to indicate the same section when straight; thus there are thin rods and thick rods, just as there are thin wires
6151 and thick wires. In purchasing a wire it will generally be found in the shops coiled, unless specifically referred to as "straightened wire," in which case, however, it is also designated as "rod." While the term "wire" is not limited to a round section, most wires in use are round, simply because this section permits coiling without presenting corners or edges. Rods may be round, square, or flat, being generally made straight to serve some particular purpose, and being given the shape and section required; however, wires are also made for special purposes of
6152 square, rectangular, elliptical and flat sections. The terms are interchangeable sometimes without restriction of any kind. Pinion wire, for example, is a rod

formed with lips or teeth from which pinions can be 6153
cut; it is like a fluted rod.

28 Q. So far as regards the porosity or the specific resistance of the carbon composing the burner of an incandescent lamp, will it make any difference whether the burner is formed by first giving shape to the crude material and then carbonizing it; or first carbonizing a larger mass of the material and cutting out the burner from such carbonized mass?

A. It will ordinarily make no material difference. Thus a piece of paper carbonized as a sheet might be
cut in strips after carbonization or the same piece 6154
might be cut into strips before carbonization. The mere act of cutting does not change the texture; and the carbonization would result in either case in giving the same specific resistance. The only case that I can call to mind where there might be any difference introduced, would be where a very large mass, say of wood, was carbonized and would confine gases in its pores; or where on account of the very large mass the access of heat to all portions was somewhat restricted.

6155

29 Q. State whether you know of any incandescent lamps in practical use in which the burner is of carbon and made straight?

A. Yes, I know of such lamps. I have seen lamps called Bernstein lamps in which the carbon incandescent conductor was straight, extending between the supporting wires to which its ends were attached. I also know of lamps like the one which I have in my hand being in use, in which the carbon is made of two straight pieces forming a sort of elongated V, the two
straight pieces being cemented together at the meet- 6156
ing point or angle of the V, while the other ends are attached to the platinum wires respectively. I have

6157 seen Bernstein lamps of the kind before referred to in use as far back as 1882 or '3; the other lamps I have not seen in use except during the past year.

Defendant's counsel offers in evidence the lamp with the V-shaped burner referred to by the witness, and the same is marked "Defendant's Exhibit V-Burner Lamp."

30 Q. Please state whether at the date of the Edison patent in suit the dynamos that were then in use and adapted for running incandescent lamps in mul-
6158 tiple, together with the engines that were used to drive them, were capable of developing a current practically free from fluctuations; or, in other words, a current which would not by its fluctuations seriously impair the steadiness of the light developed by the lamp?

A. My recollection is that the engines in use with dynamo-electric machines at the time mentioned were rather unsteady and inaccurate in governing, the result of which was that the strokes of the engine as well as the action of the governor were visible in the
6159 lamps when they were of small carbon without coiling. Improvements in both dynamos and driving machinery have been made subsequently to the time mentioned, particularly the introduction of high-speed engines and the introduction of heavy-fly-wheel engines, which show much less or no appreciable effect of this kind. The dynamo machines themselves, which originally were apt to spark at the commutator and introduce quick fluctuations of current, have been so far improved as to give very little, if any, such effect. It was generally known and recognized at the time of
6160 the issue of the patent, that machines whose field magnets were excited in shunt were very sensitive to fluctuations of speed in driving, which produced differences of electro-motive force on the lines leading from

the machine. In other machines, such as those in 6161
which the field magnets were in series, the fluctuations were in a measure smoothed out by the coils of the fields.

31 Q. Have you seen the small Edison lamp commonly known as the "Pea" lamp?

A. Yes, I have seen such lamps.

32 Q. Please state whether that lamp is adapted for use in multiple arc in large numbers in a general system of electric lighting?
6162

Objected to as immaterial and frivolous, and as tending to waste the time of counsel.

A. No, I do not think it is. The lamp, if put in multiple arc in large numbers would require enormous conducting mains to carry current to it economically for distribution. The word "enormous" would hardly be expressive enough in such a case. The general system of distribution in multiple arc requires, as has been stated before, a relation between the resistance of the mains and the lamps such that the currents can 6163
be conveyed to the lamps without involving a large waste of energy, both for economical reasons as to cost of electric energy, and on account of the necessity imposed for keeping the lamps at uniform brilliancy when a portion of the load or a number of lamps in use is removed.

32½ Q. What can you say as to the adaptability of the Edison "municipal" lamps for use in multiple-arc in large numbers in a system of general distribution of the electric light?
6164

Objected to as immaterial.

A. They are not so adaptable, for the same reasons

6165 as those just pointed out. They are constructed of comparatively so low a resistance as to allow a current to pass readily through them in bringing them to incandescence, which enables them to be strung in series or upon series lines one after the other.

33 Q. If at the date of the patent in suit a lamp like one of the "Edison" municipal lamps had been shown to a person familiar with the laws of electricity, and he had been requested to construct, or cause to be constructed, other lamps of the same general character,
6166 but so changed as to permit the lamp to be used economically in large numbers in multiple arc, the candle-power of the lamp remaining the same, would such person in your opinion have known what changes it would have been necessary to make in the size and proportions of the carbon to adapt the lamp to its new use?

Objected to as immaterial.

A. I think without question he would. He would have known the cause of the lamp being not adapted to such use and would have known that the requisite
6167 for adaptation was simply the lessening of the current required to operate it and the raising of the electromotive force. I have already pointed out that this kind of adaptation was used and well understood where distance of conveyance of energy without undue loss on the lines was to be attained. It would also have been known that these changes here indicated would require to be made while maintaining the incandescence of the conductor, that is, its temperature; and the maintaining of the incandescing temperature simply means that the radiating surface must be
6168 proportioned in one lamp as in the other, so that the current would not overheat any portion of the section of the conductor, nor, on the other hand, fail to heat

it. This adaptation is the same as in bringing to in- 6169
candescence, metal wires or other resistances in the path of the current, for the purpose of lighting, or for fuses and the like.

34 Q. Have you read British patent No. 10,919 granted to Edward A. King in 1845; and have you also read the testimony of Dr. Morton, as given in answer to questions 31 to 40 inclusive in regard to the said King patent and the lamps therein described?

A. Yes, I have read the patent and the testimony referred to. 6170

35 Q. State how far you agree with Dr. Morton in the views which he expresses in said testimony?

A. I agree thoroughly with Professor Morton in the views there expressed as regards the substitution of Sprengel or Geissler pumps for producing the Torricellian vacuum. I would say that I would be, if anything, more emphatic than Dr Morton in regarding such substitution as a well-known, natural procedure at any time about and subsequent to the year 1870. Such pumps were used frequently to se-
cure the best vacua. They were known as used and 6171
useful long prior to the issue of the patent in suit, for removing in the best possible manner, air or gases so as to obtain an excellent vacuum. The Geissler mercury pump was referred to in the text books constantly as the means for obtaining very high vacua not attainable with the ordinary mechanical or cylinder pumps.

I regard, also, that no other interpretation can reasonably be placed upon the paragraph quoted in question 34 of Professor Morton's testimony, than is
given to it by Professor Morton himself. This refers 6172
to the sealing of the lamp when it is to be used for submarine purposes. The words "suitably sealed" in the King patent, can, in my opinion, refer

6173 to no other procedure than that commonly known in securing a vacuum; that is, the melting of the wires into the glass, particularly as the wire at the top of figure 2, is referred to as a platinum wire "sealed in" at the top. The same word "sealed" being used in connection with the closure of the lamp for immersion under water, can but mean that the treatment was to be the same as that already set out for the platinum wire before mentioned; that is, another wire was to be sealed in at the bottom to close the lamp hermetically.

6174 I am also confirmed in this understanding by the statement in the patent that the lamp is to be sealed and can be then applied to submarine lighting, and also to the illumination of places where it is necessary to guard against the inflammation of highly combustible or explosive compounds, as in powder magazines, and so forth—a condition of use for which the *sealed* lamps of to-day are found very well suited.

In regard to the character of the carbon burner to be used, it is quite evident that the King patent contemplates the use of quite small or thin carbons, such as would give a considerable resistance to the current;

6175 particularily as at the date of the patent itself the sources of current, such as magneto-electric machines mentioned in the patent, were comparatively feeble. The King patent points out that when platinum is used it is to be "exceedingly thin" and lays down a special process for producing such exceedingly thin platinum, and says: "In this way it may be obtained so thin that on holding it before a printed page the letters can be distinguished through it." King is evidently making the platinum as thin as possible in order to obtain a comparatively high resistance in the

6176 burner, and uses a strip of foil because by that means he can secure a definite radiating surface with such thin material. It is only reasonable that the inventor

in substituting carbon for this exceedingly thin plati- 6177
num strip, should have given to the carbon as stated substantially a small section or made it in the form of a thin strip or pencil, in order that its conductivity should not be so great as to allow the current to pass without bringing it to full incandescence. That the carbon is to be thin, is also indicated by the fact of the use of the bridge, I, of porcelain, for taking the mechanical strain which would otherwise be thrown upon the carbon itself. The mention also of the use of the saw and file in obtaining a thin strip of hard carbon, indicates to my 6178
mind that the inventor did not consider that mere sawing would furnish the required thinness, but that the burners would be required to be filed down to the desired shape and thinness after being cut out by sawing.

I therefore quite agree with Professor Morton in the opinions and statements he has made in his testimony referred to.

Adjourned to February 8th, 1890.

6179

Boston, Mass., February 8th, 1890.

Met pursuant to adjournment.

Present: Counsel as before.

Examination of the witness Thomson continued.

36 Q. Assume a lamp with a carbon burner and of the modified construction referred to in the British patent of King of 1845, made with that care and in 6180
the manner which a person skilled in the art in January 1879, would naturally have adopted; how would such lamp compare in operativeness with a lamp like

6181 that shown in the drawings of the patent in suit, made
with a tar-putty burner under the instructions of
the patent and without the use of inventions not
known to the art at the date of said patent?

A In my opinion it would be a lamp superior to that
made with the tar putty and in accordance with the
instructions given in the specification of the patent
in suit. There were means known for obtaining high
vacua, and for producing carbons of the required
character to be mounted in the lamp; and the sealing
of the lamp as described would, of course, prevent
6182 leakage into the vacuous space.

37 Q. Please state whether it is not a fact that
about the years 1878 and '9 there was a remarkable
impulse in the art of electric lighting; and if so, to
what do you attribute such fact?

A. There was undoubtedly such an impulse. From
the successful laying of the Atlantic cable up to the
years 1876 and '7 the public had heard very little of
electrical development. The bringing out of the
speaking telephone naturally attracted attention to
6183 the possible accomplishments in the application of
electricity. The telephone began to be known gener-
ally about 1877 and '78. The years 1878 was marked
by the bringing out also of the Jablochkoff candle
and the production thereby of units of illumination
over a district on the principle of arc lighting. The
Exhibition in Paris in the same year was also the occa-
sion of the exhibition of electrical appliances particu-
larly connected with the Jablochkoff candle, which at
the time was used to illuminate one or more of the
streets in Paris.

These events naturally drew a decided attention
6184 towards industrial electrical developments, and gave
rise to a widespread interest in anything which might
be done in that field.

The dynamo-electric machine, also, in its improved 6185
forms began to be brought out and publicly known
about the same time, the Gramme machine having
been invented about the year 1859, but not reaching
industrial uses until a number of years later. The
Siemens machine or Hefner-Alteneck dynamo in like
manner came into prominence at the same period, hav-
ing been invented about 1873, and shown in a com-
pleted or more or less perfected state in 1878 at the
Exhibition.

A good deal of the electrical literature of the time
began to be turned in the direction of the future 6186
possibilities, not only in electric lighting but also in
other fields.

38 Q. Were you present at the Academy of Music
in Philadelphia in November 1878 on the occasion of
the lecture given there by Professer Barker, in which
he gave some account of the new platinum incandes-
cent lamp which he said had been invented by Mr.
Edison?

A. I was present at a lecture given in the Academy
of Music at the time mentioned, but I do not recollect
that he gave an account of a platinum burner specifi- 6187
cally; but I do recollect that he referred to his having
visited Mr. Edison's laboratory and having seen the
lamps there which in his mind solved the problem of
electric lighting for general use, saying that he had
seen a number of steady, brilliant, lights of moderate
candle power which would render the light compara-
tively very cheap.

This is the substance of what I recollect was said
but of course I cannot at this time recall any of the
words used.

6188

39 Q. In giving the substance of Professor Barker's
statements about Mr. Edison's invention, you have

6189 used the expression "comparatively very cheap." What do you mean by that?

A. Cheap as compared with the known forms of illumination, such as gas. I had known of the platinum experiments, and supposed that the lamp must be the platinum and iridium burner, though I do not recollect that Professor Barker discribed it at all.

40 Q. Does the Thomson-Houston Company, with which you are connected, make lamps for commercial use that are specially designed for work "in series"?

6190 A. Yes, the company makes a number of types of such lamps for use in series, either on arc-light circuits in series with the arcs, or on circuits upon which no arc lights are run. The company has a very large number of series circuits working under its systems, and on most of them, I think, a proportion of the lamps, sometimes all the lamps, are "series" lamps.

41 Q. Will you produce a specimen of one of these Thomson-Houston "series" lamps?

A. I have one here which is intended for standard circuits of 10 amperes and gives a light of 20 candles.

6191 The resistance hot is about 72 hundredths of an ohm, and the width of the strip of carbon is about 4-100ths of an inch, and its thickness about 17-100ths, the length of the strip being an inch and three-eighths nearly.

Defendant's counsel offers in evidence the lamp referred to by the witness, the same being marked Defendant's Exhibit Thomson-Houston Series Lamp.

42 Q. What is the most powerful incandescent

6192 lamp that you have ever known of as being used practically?

A What has been called the 1500 candle lamp of a

type designated the "Sunbeam" lamp. I have seen 6193
such lamps in use, particularly in London.

43 Q. Can you produce one of these "Sunbeam" lamps?

A. I here produce one which is broken. The lamp has been run quite a time, and was, I believe, broken by accident or purposely to get at the carbon. This particular lamp, I believe, is rated at 500 candles illuminating power, requiring about 65 volts with a current of approximately 16 amperes. The thickness of the carbon conductor is about a twentieth (1-20) of 6194
an inch or five one-hundredths (5-100), possibly a little more. The lamp in its present condition has several loose pieces of the carbon in the bulb which are pieces of the original carbon that connected the wires leading into the bulb. Calculating the resistance from the electro-motive force, 65 volts, and current, would give 4 ohms as the working resistance.

Defendant's counsel offers in evidence the lamp produced by the witness, and the same is marked "Defendant's Exhibit Sunbeam Lamp." 6195

44 Q. Can you tell from an inspection of the burner of the Sunbeam lamp how it was made?

A. No, not with any certainty. It appears to me to have undergone a certain amount of treatment in hydro-carbon, though I am not quite sure of that. The carbon rod is evidently made up by either the *filiere* process or by building up of a thinner mass by treatment. A microscopic examination might discover which of these ideas was correct. I think that in any case it had had a coating of treated or deposited carbon put upon it. 6196

The cross-examination of this witness stands adjourned to such time as may hereafter be agreed upon.

6197 BOSTON, MASS., Feb. 17, 1890.

Met pursuant to agreement.

Present, counsel as before.

CROSS-EXAMINATION OF THE WITNESS ELIHU THOMSON, BY MR. DYER:

45 x-Q. In answer 2d you state that you were selected to delivor a course of lectures on electricity in 1877, by the Franklin Institute. Were those lectures
6198 published.

A. No, I believe not.

46 x-Q. You also lectured before the Franklin Institute in 1879, beginning with the first Thursday in January, did you not?

A. I have no recollection of the exact date of beginning any lectures in 1879, though I did lecture, I believe, early in 1879, at the Franklin Institute on several topics.

6199 47 x-Q. Was one of those topics electric lighting?

A. Yes.

48 x-Q. I find a note in the Franklin Institute Journal for 1878, under the head of "Lectures" that you were put down to deliver five lectures beginning Thursday, January 2, 1879, and that one of these lectures was on the subject of electric lighting. Is it your recollection that you delivered the lectures in accordance with the notice?

A. I see no reason to doubt the correctness of the notice, though of course I do not recollect the dates
6200 at present.

49 x-Q. Was that lecture on electric lighting published?

A. No, I believe not, and at the most there may 6201
have been brief notices of the lectures published in the newspapers at the time. The lectures were extempore, and not reported as I remember.

50 x-Q. In answer 2 you speak of numerous experiments made by yourself "a large majority of which were connected with the subject of electric lighting." Do you refer to arc lighting in this statement?

A. Experiments were mostly connected with dynamo machines intended for the production of electricity, particularly with a view to its use for arc 6202
lighting. Some of the experiments related to electric arc lamps; some to electric deposition. I made experiments covering quite a range, and would hardly be able to recall their limits now.

51 x-Q. When did your experiments on electric lamps begin, and what was the nature of them.

A. I had worked with and used electric lamps prior to 1870, and occasionally thereafter until I began to develope an arc-lighting system in about 1876 and 1877. 6203

52 x-Q. This is the work you undertook in connection with Prof. Houston.

A. Yes, some of this work was undertaken and worked out in connection with Prof. Houston, some of it not; and there other matters which were worked on jointly.

53 x-Q. The commercial arc-lighting system with the commercial introduction of which you and Prof. Houston were connected, was the result of your joint efforts was it not? 6204

A. The early work was done conjointly in great part, though some of the work I did individually,

6205 particularly about the time of the commercial working.

54 x-Q. How did it happen that you and Prof. Houston took up the subject of electric lighting with a view of devoloping commercial apparatus?

A. That is a very difficult question to answer. I know that from about 1870 we were both closely interested in the developement of arc lights, and from about 1873 or 1874 equally interested in the developement of dynamo machines. We believed in a great future for arc lighting, and so far as I can now state.
6206 I think that that is how it happened. We found ourselves together in the same institution and naturally talked over the possibilities of the business.

55 x-Q. That is, being thrown together in your occupations, you discussed the possibility of making electric lighting a commercial industry, made up your mind that it was coming and decided to develope commercial apparatus yourselves. Is that it in a rough way?

A. Not exactly that either. The incidents con-
6207 nected with the commercial developement were rather spontaneous and not connected directly with our own decisions. I thought undoubtedly that there was a large field for electric lighting and the actual direction in which our efforts were spent in commercial developement was determined by the desire of a party to have us build a commercial system for him so that he might exploit it. This party was Mr. Geo. S. Garrett, of Philadelphia, who happened to see one of the dynamos built by us in operation at the Franklin Institute Hall. He simply put the question whether we thought we could produce such a machine operat-
6208 ing, say, 4 lights. If we could, he thought he could sell the machine. We produced the machine, and the demand for increased capacities was a natural conse-

quence. Out of this grew the arc-lighting business 6209
which I have been connected with and which was started early in 1879 as a commercial enterprise.

56 x-Q. Before that time however, you and Prof. Houston had experimented in electric lamps, and had made some progress in the construction of suitable arc lamps for commercial work?

A. Yes, to a certain extent that is true.

57 x-Q. In your answer 2, you speak of having contributed at times to the technical and electric journals. 6210
Do you include in these contributions those made by Prof. Houston and yourself jointly?

A. In a general way, yes; though I should in referring to them specifically, they have used the name of Prof. Houston as working along with myself in the matter.

58 x-Q. Do you recollect the arc lamp with vibrating electrodes which is credited in publications to you and Prof. Houston?

A. Yes, I recollect the lamp. 6211

59 x-Q. I call your attention to a publication in the Journal of the Franklin Institute for October, 1878, entitled "A New Electric Lamp, by Profs. Elihu Thomson and Edwin J. Houston, of the Philadelphia Central High School"; also to a publication in the Journal of the Franklin Institute for January, 1879, entitled 'Induction Apparatus for Reversed Currents," by Profs. Elihu Thomson and Edwin J. Houston." Do these describe the vibrating arc lamp proposed by you and Prof. Houston?

A. The first one appears to describe the lamp—the 6212
vibrating arc lamp, or at least one form of it; and the second refers to the vibrating arc lamp in connection with an induction coil.

6213 60 x-Q. Do you recollect those publications, and were they caused to be made by you and Prof. Houston, as stated in their titles?

A. Yes; the publications I think are the same as those I recollect. I believe the occasion of their publication was that both the lamp and coil had been experimented with at the Franklin Institute with the dynamo which we had there, and the Secretary requested that a note concerning them be given for the Journal. That is my recollection of how the matter stood.

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The articles referred to are offered in evidence by counsel for complainant, and it is stipulated that the said articles are as follows:

Counsel for defendant hereby waives proof of publication of the articles at the dates recited.

" JOURNAL OF THE FRANKLIN INSTITUTE.

" OF THE STATE OF PENNSYLVANIA.

6215 "Vol. CVI. October, 1878. No. 4

" (VOL. LXXVI. THIRD SERIES.)

" A NEW ELECTRIC LAMP.

"BY PROFS. ELIHU THOMPSON AND EDWIN J. HOUSTON.
" OF THE PHILADELPHIA CENTRAL HIGH SCHOOL.

"The following is a description of one of the forms "of electric lamp which we have devised, to be used "in connection with our system of electric lighting:

6216 "A flexible bar, *b*, of metal is firmly attached at one "of its ends to a pillar, *p*, and bears at its other end "an iron armature, *a*, placed opposite the adjustable

"pole-piece of the electro-magnet, *m*. A metal collar, 6217
"*c*, supports the negative electrode, the positive elec-"trode being supported by an arm, *j*, attached to the "pillar, *p*. The pillar *p*, is divided, by insulation at *i*, "into two sections, the upper one of which conveys "the current from the binding-post marked x, to the "arm *j*, and the rod, *r*, supporting the positive elec-"trode.

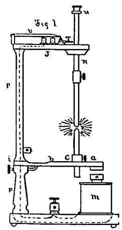
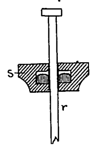


Fig 2 6218



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"The magnet, *m*, is placed as shown by the dotted "lines, in the circuit which produces the light. The "pillar *p*, is hollow, and has an insulated conducting "wire enclosed, which connects the circuit-closer, *v*, to "the binding-post, marked—— The current is con-"veyed to the negative electrode, through *b* and the "coils of the magnet *m*. When the electrodes are in "contact, the current circulating through *m*, renders 6220
"it magnetic and attracts the armature, *a*, thus separat-"ing the electrodes, when, on the weakening of the

6221 "current, the elasticity of the rod, *b*, again restores "the contact. During the movement of the negative "electrode, since it is caused to occur many times per "second, the positive electrode, though partially free "to fall, cannot follow the rapid motions of the nega- "tive electrode; and, therefore, does not rest in per- "manent contact with it. The slow fall of the posi- "tive electrode may be insured either by properly pro- "portioning its weight, or by partly counterpoising it. "The positive electrode thus becomes self-feeding.

"The rapidity of the movement of the negative
6222 "carbon may be controlled by means of the rigid bar, "*l*, which acts, practically, to shorten or lengthen the "part vibrating.

"In order to obtain an excellent but free contact of "the arm *j*, with the positive electrode, the rod *r*, "made of iron or other suitable metal, passes through "a cavity, *s*, Fig. 2, filled with mercury, placed in elec- "trical contact with the arm, *j*. Since the mercury "does not wet the metal rod, *r*, and the sides of the "opening through which it passes, free movement of "the rod is allowed without any escape of the mercury.
6223 "We believe that this feature could be introduced "advantageously into other forms of electric lamps.

"In order to prevent a break from occurring in the "circuit, when the electrodes are consumed, a button *r* "is attached to the upper extremity of the rod R, at "such a distance that when the carbons are consumed "as much as is deemed desirable, it comes into contact "with a tripping lever *t*, which then allows two con- "ducting plugs, attached to the bar *v*, to fall into "their respective mercury cups, attached, respectively, "to the positive and negative binding-posts by a direct "wire. This action practically cuts the lamp out of
6224 "the circuit.

"Philadelphia, September 19th, 1878."

" JOURNAL OF THE FRANKLIN INSTITUTE. 6225

" OF THE STATE OF PENNSYLVANIA.

"Vol. CVII. January, 1879. No. 1.

(Vol. LXXVII. Third Series.)

"INDUCTION APPARATUS FOR REVERSED " CURRENTS.

" By Profs. Elihu Thomson and Edwin J. Houston.

"The following apparatus was devised by the au- 6226 "thors for the purpose of obtaining induced reversed "currents for use in electric illumination. These cur- "rents we used with a vibrating lamp, a description of "which has already been published.

"Our method of operation is as follows: A reversed "primary current is caused to induce reversed secon- "dary currents in secondary coils provided therefor. "These secondary currents are caused to give vibra- "tions to carbon electrodes, and thereby at the same "time produce a partial arc between them. With suffi- "cient strength of primary current, a considerable "number of secondary currents are obtained, each of 6227 "which is able to operate one of our vibrating lamps.

"The use of a vibrating lamp admits of a wide range "in the size of the currents employed. When a light "of very moderate intensity is desired, the carbons are "made of a very small size, and are placed in a closed "glass vessel for protection from the atmosphere.

"To moderate the brilliancy opalescent glass is used. "To obtain the highest efficiency, inductive action "from a set of primary coils, the following form of "induction coil was devised.

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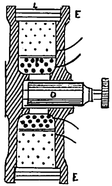

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"The primary coil, P, surrounding the core C, is "provided with a secondary coil S, adjacent to it. The "ends E and F of the bobbin are made of discs of iron "concentric with the core C and slit from centre to cir- "cumference. The outer extremities of these discs are "connected by wires or sheets of iron L, to one another "forming in this manner an induction coil encased in
6231 "iron or one whose core has its north and south ex- "tremities totally connected. The strength of the "current developed in the secondary coil is greatest "when the core C, which is movable, is inserted so that "both of its extremities are in contact with E and F. "By withdrawing this core, the current from the se- "condary coil may be weakened to almost any desired "extent. This coil is best adapted to the use of pri- "mary currents whose direction is constantly changing. "All the wire being completely surrounded by "iron, whose direction af magnetic polarization is al- "so changed, the highest inductive effect is thereby
6232 "produced in the secondary coil.

"The variations in the intensity of the induced cur- "rents will of course be followed by variations in the

"intensity of the light emitted by the lamp. The 6233
"movement of the core may, therefore, be made to in- "crease or decrease the intensity of the light."

"Lecture of Prof. Henry Morton, from American "Gas Light Journal, delivered October 18, 1878, be- "fore the American Gaslight Association."

61 x-Q. Was this vibrating lamp the first of the arc lamps designed by you and Prof. Houston?

A. That I cannot say. I would have to examine the sketches and memoranda in connection with this point before I could answer definitely. I think 6234
not however.

62 x-Q. Did you propose this vibrating lamp as one suitable for commercial use?

A If found so, I did. A proposition of the kind always involves the suitability of an apparatus; that is, the lamp itself was, as constructed, an experimental affair having enough interest attached, as we thought, to merit a note concerning its construction. I cannot say that I ever proposed to manufacture the lamp or put it to use commercially.

6235

63 x-Q. Did you have a better arc lamp for commercial use at the date of these publications than this one, or was all your work experimental at that time?

A. Yes, I believe we had much better arc lamps at that time. I had made experimental lamps a considerable period before the time and run them with dynamo machines. I cannot say that any of these lamps were constructed with especial reference to commercial use; they were generally roughly constructed and not refined in their development, so that in one sense it would be proper to say that most of the work was 6236
of an experimental character.

64 x-Q. The other lamps you refer to I assume ap-

6237 proached more nearly the present commercial types of arc lamps than did the vibrating lamp. Am I right?

A. Yes, they were lamps taking from 5 to 10 or more amperes of continous current and giving an arc light of considerable power.

65 x-Q Did you expect to get small or divided lights, suitable for domestic illumination from these other arc lamps, or lamps of that type?

A. The expectation was to get smaller lights and
6238 as it were, divide the arc light of larger power into several foci of smaller power. We realized the fact that the economy of the lighting would be largely preserved if the principles on which light by the electric arc is obtained, were retained: and that, if a light of say 20 or 30 candles, or even a little more, could be got on this principle, not only would the light be obtained extremely cheap, but it would be of a character resembling the arc light.

66 x-Q To which principle do you refer now?

A. I refer to the principle of the vibrating lamp
6239 that is, the separation of the electrodes.

67 x-Q My question was directed to the other arc lamps which you say you had at the date of these publications—not vibrating lamps—and which you think were better and which you had stated approached more nearly the construction of the commercial type of arc lamp. Did you expect with these other arc lamps to get small or divided lights suitable for domestic use?

A. I cannot remember any such expectation. I do
6240 not think the matter was considered at all whether we could or could not. The field for electric lighting by the arc was well understood to be quite new and somewhat restricted at that time. Whether an

electric arc could be made small enough, steady 6241
enough and could be regulated, I do not think entered into the consideration of the question at that time

68 x-Q. These other arc lamps, which we may distinguish from the vibrating lamps by calling them non-vibrating arc lamps, you intended to occupy a field which has since been occupied by arc lamps, did you not; that is to say, for the lighting of large spaces by large foci?

A. Yes, that was the immediate field, though I do not wish to be understood as agreeing that at any
time in 1879 I had the idea that the field was re- 6242
stricted to the particular places or conditions in which arc lights are now used, though I did know, of course, that the chances for commercial introduction of arc lights were more favorable, particularly as at that time very little series lighting had been done, the Jablochkoff system being one of the first to run a number of lights in series.

69 x-Q. In the second Franklin Institute article before referred to, that of January, 1879, you state
"The use of a vibrating lamp admits of a wide range 6243
in the size of the currents employed. When a light of very moderate intensity is desired, the carbons are made of very small size and are placed in a closed glass vessel for protection from the atmosphere."

From this I take it that you expected with the vibrating lamp to secure small or divided lights suitable for domestic illumination. Am I right?

A. We expected to get smaller divided lights; the suitability was a matter for subsequent determination. I have no doubt though that if the light
could be got steady and small enough, it might be 6244
used in all cases where steady small lights are available. I do not think this point, however, was determined at the time.

6245 70 x-Q. The vibrating lamp, however, was the type of lamp which you and Professor Houston had in mind at the time of these articles for the purpose of producing small electric lights?

A. Yes, with the understanding that they should be produced at a very small expenditure of power. We were well aware of the incandescent principle as applied to the production of light, and knew that the temperature of incandescence would naturally limit the amount of light obtainable, and so thought that if the arc light could be, as it were, reproduced in the
6246 vibrating lamp, the extraordinarily high economy might be in a measure preserved. This explains the effort made with the vibrating lamp which was really to sub-divide the electric light, the electric light being the arc light; not to multiply a number of small lights. In fact the experiments were made on the arc light machines such as are capable of giving one arc lamp, in place of which we got three smaller lights of a vibrating character.

71 x-Q. You considered however, that the solution of the problem of providing small electric lights econ-
6247 omically was more likely to be accomplished by something of the order of this vibrating lamp than by improvements upon incandescent lamps; at least, the direction that your work took would indicate this.

A. No, I considered that if the light could be produced on the arc principle a great deal more light could be got for a given expedenditure than in any other way. I was quite familiar with the fact that the incandescent principle was being worked upon by others. I knew of the Sawyer-Man lamp with its incandescent carbon enclosed in an atmosphere contain-
6248 ing no oxygen. I also knew of platinum and iridium incandescent lamps. The vibrating lamp was merely an effort to find out what the most economical source of light might be, as the arc was well known to give

about ten times the amount of light, or even more than 6249
that, than could be obtained by incandescent material heated by the current.

72 x-Q. This vibrating lamp, then, represents simply the effort of yourself and Prof. Houston to divide the electric light into small lights by the arc method.

A. Yes, it represents the effort to use the arc principle and apply to it smaller lights, which, if accomplished would have given very high economy of light production.

73 x-Q. Did not you and Professor Houston think 6250
that that was the most promising direction in which to secure divided or small lights with economy?

A. I don't know what Professor Houston thought about it. I still think it. I am not sure that the time may not come when small arc lights will be found to be the economical means of illumination. Without question the production of light economically by the arc process would be a desirable thing to do if the arcs were made small enough, say, to give fifty candles or less.

6251

74 x-Q. Why don't you do it then?

A. I am not here to say what I may or may not do I am here to answer questions touching upon my former testimony.

75 x-Q. Why did not you accomplish this by means of the vibrating lamp: that is, what were the causes of the failure of that lamp?

A. I think largely impurity in the carbons and the fact that the lamp required rather close regulation of its vibrations.

6252

76 x-Q. As a matter of fact, the vibrating lamp was

6253 never introduced commercially to any extent, was it?
A. It never was.

77 x-Q. In my former question in which I referred you to articles on the vibrating lamp, I omitted to call your attention to another article published in the Journal of the Franklin Institute for October, 1878, and entitled, "A New System of Electric Lighting by Professors Elihu Thomson and Edwin J. Houston, of the Philadelphia Central High School." Do you also recollect this article, and was it caused to be published,
6254 as recited, by yourself and Professor Houston?
A. Yes, I recollect the article, and I believe it was so published.

The article referred to is offered in evidence by counsel for complainant, and it is stipulated that the following is a copy of the said article.

"JOURNAL OF THE FRANKLIN INSTITUTE.

" OF THE STATE OF PENNSYLVANIA.
6255
"Vol. CVI. October, 1878. No. .

" (VOL. LXXVI. THIRD SERIES.)

"A NEW SYSTEM OF ELECTRIC LIGHTING.

"BY PROFS. ELIHU THOMSON AND EDWIN J. HOUSTON, OF
" THE PHILADELPHIA CENTRAL HIGH SCHOOL.

"Having been engaged in an extended series of ex-
6256 "perimental researches on dynamo-electric machines and their application to electric lighting, our attention has been directed to the production of a system, "that will permit the use of a feebler current for pro-

"ducing an electric light than that ordinarily required, 6257
"or, in other words, the use, when required, of a current of insufficient intensity to produce a continuous "arc. At the same time, our system permits the use "of a powerful current, in such a manner as to operate "a considerable number of electric lamps placed in the "same circuit.

"As is well known, when an electrical current, which "flows through a conductor of considerable length, is "suddenly broken, a bright flash, called the extra spark, "appears at the point of separation. The extra spark "will appear, although the current is not sufficient to 6258
"sustain an arc of any appreciable length at the point "of separation.

"In our system, one or both of the electrodes, which "may be the ordinary carbon electrodes, are caused to "vibrate to and from each other. The electrodes are "placed at such a distance apart, that in their motion "towards each other, they touch, and afterwards recede a distance apart which can be regulated. These "motions or vibrations are made to follow one another "at such a rate, that the effect of the light produced "is continuous; for, as is well known, when flashes of "light follow one another at a rate greater than 6259
"twenty-five to thirty per second, the effect produced "is that of a continuous light. The vibratory motions "may be communicated to the electrodes by any suitable device, such, for example, as mechanism operated by a coiled spring, a weight, compressed air, etc., "but it is evident that the current itself furnishes the "most direct method of obtaining such motion, as by "the use of an automatic vibrator, or an electric engine.

"In practice, instead of vibrating both electrodes, "we have found it necessary to give motion to but 6260
"one, and since the negative electrode may be of such "size as to waste very slowly, motion is imparted to "it, in preference to the positive. The carbon elec-

6261 "trodes may be replaced by those of various substances
"of sufficient conducting power.

"In this system, when desired, an independent bat-
"tery circuit is employed to control the extinction and
"lighting of each lamp.

"Philadelphia, September 19th, 1878."

78 x-Q. You have stated that in 1877 you took part
in certain tests of dynamo-electric machines. What
was the character of these tests with regard to the
apparatus tested in the external circuits of the ma-
6292 chine?

A. The tests were, as regards the apparatus tested
in the external circuits, arc-lighting tests with substi-
tuted resistances. The tests concerned the arc-light-
ing machines then to be found on the market, and I
believe the machines were the Brush, Wallace-Farmer,
Gramme and others which were not sent for test but
which were expected. Prof. Houston and myself had
special charge of the electrical measurements while
the other members of the committee were in charge
of the photometric measurements of the arc lights
6263 operated by the machines.

79 x-Q. Publications were made of these tests, were
they not?

A. Yes, there was a published report of the test

80 x-Q. In this connection, do you recollect a paper
reported to have been read by Profs. Edwin J.
Houston, and Elihu Thomson before the American
Philosophical Society, November 1, 1878, and publish-
ed in the Telegraphic Journal and Electrical Review
for 1879, entitled "Circumstances Influencing the Effi-
6264 ciency of Dynamo-Electric Machines."

A. I recollect a paper which was read before the
American Philosophical Society, and I suppose it may
have been published in the Telegraphic Journal,

though I had not recollected that fact. I know that 6265
it was published in the proceedings of the American
Philosophical Society, and my recollection is that it
was copied into some of the other journals or forward-
ed to them by the Secretary of the Society.

81 x-Q. You and Prof. Houston were responsible
for the preparation of this paper as appears by its
title were you not?

A. Yes, we wrote the paper.

Counsel for Complainant offers the paper 6266
in evidence and it is stipulated that the
following is a correct copy of the same.

" THE TELEGRAPHIC JOURNAL,
" and
" ELECTRICAL REVIEW.

"Vol. VII. January-December, 1879. 6267

" London, Haughton & Company.

" January 15, 1879, p. 25.

" CIRCUMSTANCES INFLUENCING THE
" EFFICIENCY OF DYNAMO-ELECTRIC
" MACHINES.

"Paper read before the American Philosophical
"Society, Nov. 1st, 1878.

" By Profs. Edwin J. Houston and Elihu Thomson. 6268

"During the recent competitive trials made at the
"Franklin Institute, as to the relative efficiency of

6269 "some different forms of dynamo-electric machines,
"the authors having been entrusted with the work of
"determining the relations between the mechanical
"power consumed, and the electric and thermic effects
"produced, took the opportunity thus afforded, to
"make a careful study of many interesting cir-
"cumstances which influence the efficiency of these
"machines.

"It is proposed in the present paper, to select from
"the many circumstances thus noticed, a few of the
"more interesting, r eserving the others for future
6270 "consideration.

"It will readily be understood, from the compara-
"tively new field in which we had been working, no
"reliable data of the electrical work of these machines
"having before been obtained, that difficulties con-
"stantly arose owing to necessary conditions of opera-
"tion, and new developments as to the behavior of the
"machines under varied conditions, were constantly
"met.

"A convenient arrangement of the particular cir-
"cumstances we are about to discuss may be, 1st:
"Those affecting the internal work of the machine:
6271 "2nd, Those affecting the external work, and 3rd,
"The relations between the internal and external
"work.

"The mechanical energy employed to give motion
"to a dynamo-electric machine is expended in two
"ways, viz.: 1st, In overcoming friction and the re-
"sistance of the air: and 2nd, In moving the arma-
"ture of the machine through the magnetic field, the
"latter of course constituting solely the energy avail-
"able for producing the electrical current. The great-
"est amount of power expended in the first way, was
6272 "noticed to be about 17 per cent. of the total power em-
"ployed. This expenditure was clearly traceable to
"the high speed acquired by the machine. The speed,
"therefore, required to properly operate a machine

"is an important factor in ascertaining its efficiency. 6273
"The above percentage of loss may not appear so
"great, but when it is compared with the total work
"done in the arc, as heat, constituting, as it did, in
"this particular instance over 50 per cent. of the
"latter, and about 33⅓ per cent. of the total work of
"the circuit, its influence is not to be disregarded.
"In another instance, the work consumed as friction
"was equal to about 80 per cent. of that appearing in
"the arc as heat, while in the Gramme machine experi-
"mented with, this percentage fell to 20 per cent. of
"that which appeared in the arc as heat, and was only 6274
"about 7 per cent. of the total power consumed in
"driving the machine.

"In regard to the second way in which mechanical
"energy is consumed, viz.: in overcoming the resis-
"tance necessary to move the armature through the
"magnetic field, or in other words, to produce electri-
"cal current, it must not be supposed that all this
"electrical work appears in the circuit of the machine,
"since a considerable portion is expended in producing
"what we term the local action of the machine, that
"is, local circuits in the conducting masses of metal, 6275
"other than the wire, composing the machine.

"The following instances of the relation between
"the actual work of the circuit, and that expended in
"local action, will show that this latter is in no wise
"to be neglected. In one instance an amount of power
"somewhat more than double the total work of the
"circuit was thus expended. In this instance also it
"constituted more than five times the total amount of
"power utilized in the arc for the production of light.
"In another instance it constituted less than one-third
"the total work of the circuit, and somewhat more
"than one-half of the work in the arc. 6276

"Of course work expended in local action is simply
"thrown away, since it adds only to the heating of

6277 "the machine. And since the latter increases its elec-"trical resistance, it is doubly injurious.

"The local action of dynamo-electric machines is "analogous to the local action of a battery, and is "equally injurious in its effects upon the available cur-"rent.

"Again, in regard to the internal work of a machine, "since all this is eventually reduced to heat in the ma-"chine, the temperature during running must con-"tinually rise until the loss by radiation and convec-"tion into the surrounding air, are eventually equal to
6278 "the production, and the machine will at last acquire a "constant temperature. This temperature, however, "will differ in different machines according to their "construction, and to the power expended in produc-"ing the internal work, being, of course, higher when "the power expended in producing the internal work "is proportionally high.

"If therefore a machine during running acquires a "high temperature when a proper external resistance "is employed, its efficiency will be low. But it should "not be supposed that because a machine when run
6279 "without external resistance, that is, on short circuit, "heats rapidly, that inefficiency is shown thereby. On "the contrary, should a machine remain comparatively "cool when a proper external resistance is employed, "and heat greatly when put on short circuit, these "conditions should be regarded as an index of its "efficiency.

"As a rule the internal resistance of dynamo-elect-"ric machines is so low that to replace them by a "battery, the latter, to possess an equal internal resis-"tance, would have to be made of very large dimen-"sions, so that the efficiency of Dynamo-Electric
6280 "Machines, cannot be stated in terms of battery cells "as ordinarily constructed.

"In regard to the second division, viz.: the external

"work of the machine, this may be applied in the pro-"duction of light, heat, electrolysis, magnetism, &c. 6281

"Where it is desired to produce light, the external "resistance is generally that of an arc formed between "two carbon electrodes; the resistance of the arc is "therefore an important factor in determining the "efficiency. To realize the greatest economy, the re-"sistance of the arc should be low, but nevertheless "should constitute the greater part of the entire cir-"cuit resistance.

"In some of our measurements the resistance of the "arc was surprisingly low, being in one instance .54 6282
"ohm, and in another .79 ohm. It was, however, in "some instances as high as 3.18 ohms.

"It may be noted as an interesting fact that where "the greatest current was flowing, the resistance of "the arc thereby produced was low. This is un-"doubtedly due to higher temperature and increased "vaporization from the carbons. In this latter case "also the greatest amount of light was produced.

"The amount of work appearing in the arc as "measured by the number of foot pounds equivalent "thereto, is not necessarily an index of the lighting "power. In two instances of measurement, the amount 6283
"of energy thus appearing in the arc was equal, while "the lighting powers were proportionately as three to "four. This apparent anomaly is explained by con-"sidering the resistance of the arc, it being much less "in the case in which the greater light was produced. "The heat in this case being evolved in less space the "temperature of the carbons, and therefore their light-"giving powers, was considerable increased.

"A few remarks on the economical production of "light, from an electrical current may not be out of "place. The light emitted by an incandescent solid 6284
"will increase as its temperature is increased. In the "voltaic arc the limit to increase of temperature is in "the too rapid vaporization of the carbon. Before

6285 "this point is reached, however, the temperature is
"such that the light emitted is exceedingly intense.
"No reliable method of measuring the temperature of
"the arc has as yet been found.

"A well known method of obtaining light from
"electrical currents is by constructing a resistance of
"some material such as platinum, having a high fusing
"point and heated to incandescence by the passage of
"a current. When platinum is employed the limit to
"its increase of temperature is the fusing point of the
"platinum, which is unquestionably but a fraction of
6286 "the temperature required to vaporize carbon. Were
"the falling off in the amount of light emitted merely
"proportional to the decrease in temperature, the
"method last described might be economical. Unfor-
"tunately, however, for this method, many facts show
"that the decrease in the light emitted is far greater
"than the decrease of the temperature. Most solids
"may be heated to 1,000° F. without practically
"emitting light. At 2,000° F. the light emitted is
"such that the body is said to be at a bright red: at
"4,000° F., the amount of light will have increased
"far more than twice, probably as much as four times
6287 "that emitted at 2,000° F. It is reasonable to suppose
"that with a further increase of temperature the same
"ratio of increase will be observed, the proportionate
"increase in luminous intensity far exceeding the in-
"crease in temperature.

"It would therefore appear that the employment of
"a resistance of platinum or other similar substance,
"whose temperature of alteration of state as compared
"with that of carbon is low, must be far less economi-
"cal than the employment of the arc itself, which as
"now produced has been estimated as about two or
6288 "three times less expensive than gas.

"Indeed, it would seem that future improvements
"in obtaining light from electrical currents will rather
"be by the use of a sufficient resistance, in the most

"limited space practicable, thereby obtaining in such 6289
"space the highest possible temperature.

"Perhaps the highest estimate that can be given of
"the efficiency of dynamo-electric machines as ordin-
"arily used, is not over 50 per cent. Our measure-
"ments have not given more than 38 per cent. Future
"improvements may increase this proportion; since
"the efficiency of an ordinary steam engine and boiler
"in utilizing the heat of the fuel is probably over-
"estimated at 20 per cent., the apparent maximum per-
"centage of heat that could be recovered from the cur-
"rent developed in a dynamo-electric machine, would 6290
"be over-estimated at 10 per cent. The economical
"heating of buildings by means of electricity may
"therefore be regarded as totally impracticable.

"Attention has, long ago, been directed to the use
"of dynamo-electric machines for the conveyance of
"power. Their employment for this purpose would
"indeed seem to be quite promising. Since in this case
"one machine is employed to produce electrical cur-
"rents, to be reconverted into mechanical force by
"another machine, the question of economy rests in
"the perfection of the machines and in their relative
"resistances. 6291

"In respect to the relations that should exist
"between the external and internal work of dynamo-
"electric machines, it will be found that the greatest
"efficiency will, of course, exist where the external
"work is much greater than the internal work, and
"this will be proportionately greater as the external
"resistance is greater. Our measurements gave in one
"instance the relation of .82 ohm. of the arc to .49
"ohm. of the machine, a condition which indicates
"economy in working. The other extreme was found
"in an instance where the resistance of the arc was 6292
"1.98 ohms., while that of the machine was 4.60 ohms.,
"a condition indicating wastefulness of power."

6293 82 x-Q. When was the arc-lighting business based on the inventions of yourself and Prof. Houston, inaugurated?

A. The first arrangements for manufacturing I believe, were completed early in the Winter of 1878 and 1879, or early in the following Spring.

83 x-Q. What was the company known as at that time?

A. There was no special company; Mr. Geo. S.
6294 Garrett carried on the business as a private enterprise.

84 x-Q. When was it put into a corporation, approximately?

A. As I remember it, the steps were taken the subsequent Winter and the organization completed about the middle of 1880.

85 x-Q. Business in the apparatus, however, was being done, at least during the latter part of 1879 and early in 1880?

A. Yes, from about March, 1879, and thereafter
6295 the business was continued.

86 x-Q. Was the business large, at first?

A. It depends on what is meant by "large" in this connection; I should say it was rather limited as compared with present business.

87 x-Q. How many arc lamps do you think you put out the first year?

A. That I cannot say; I think not very many.

6296 88 x-Q. We will return to this subject again, in connection with your criticism of Prof. Barker's statement as to the growth of the Edison incandescent business. At present I would like to know if you recollect a

meeting of the Franklin Institute, on January 21st, 6297
1880, reported in the Journal of the Institute for March, 1880, at which meeting you are reported to have been present, and a copy of the report of which meeting I now hand you?

A. Yes, I recollect a meeting early in 1880.

89 x-Q. Did you speak upon that occasion, and is the report of what you said substantially a correct one?

A. I made some remarks on that occasion and I believe the report is correct, substantially.

Counsel for Complainant offers in evidence 6298
the report referred to and the matter printed in connection therewith, the same being entitled "The Edison Electric Light, Proceedings of the Meeting of the Institute, January 21st."

And it is hereby stipulated that the report referred to, was published in March, 1880, and is a report of the proceedings of a meeting held January 21st, 1880, and that the following is a correct copy of the report:

6299

" JOURNAL OF THE FRANKLIN INSTITUTE

" OF THE STATE OF PENNSYLVANIA.

"Vol. CIX. March, 1880. No. 3.

" (THIRD SERIES. LXXIX.) p. 145.

" THE EDISON ELECTRIC LIGHT.

" PROCEEDINGS OF THE MEETING OF THE INSTITUTE,

" January, 21st. 6300

"MR. A. E. OUTERBRIDGE, JR., made the following "remarks:

6301 "Mr. Chairman and Gentlemen: In acceding to the "request of the Secretary of the Institute that I "should give the members an account of my recent "visit to Menlo Park, and the system of electric light-"ing now being practically tested there, I wish to "premise that I do not feel especially well qualified "by reason of any superior technical knowledge or "experience to do full justice to this most interesting "topic, in regard to which there exists a great diver-"sity of opinion among the doctors. I shall not, "therefore, venture to express any opinion as to the
6302 "originality of Mr. Edison's devices or the possible "future economy or practicability of his light. I shall "merely endeavor to describe, as concisely as possi-"ble, for the benefit of our members who may not "have had an opportunity of seeing this light, the "general plan of operations as I observed it at Menlo "Park, and to present a resumé of the history of the "matter to be discussed this evening.

"It is scarcely necessary for me to explain to you "that the problem which Mr. Edison has been en-"deavoring to solve for the past two years has been "the production of an electric illumination by the sys-
6303 "tem known as "incandescence" of a solid material, as "distinguished from the electric arc between the car-"bon pencils, with which we are all so familiar. That "this problem is by no means a new one many of you "know, and Mr. Edison is not, and does not claim to "be, the pioneer in this field of research. As long "ago as 1845 an American inventor named Starr ob-"tained a patent in England for a system of incande-"scent electric lighting, the specification reading al-"most like a description of Mr. Edison's apparatus.

"Starr's schemes were prematurely extinguished on
6304 "account of his sudden death, but he was followed by "a number of others who produced incandescent lamps "depending on the same principles, all of them "promising in their embryonic stage brilliant pros-

"pects of future usefulness, but they have all failed 6305
"to fulfill the expectations of their sanguine authors; "and have remained buried in almost complete ob-"livion. It is not unnatural, therefore, that scien-"tists who are cognizant of the immense difficulties in "the way of a practical solution of a problem which "is, in theory, extremely simple, should hesitate to "concede a better fortune to this latest child of even "so herculean an inventive genius as Mr. Edison.

"The earlier workers in this field relied entirely "upon the expensive consumption of zinc in the gal-"vanic battery for their source of electricity, and it 6306
"is difficult to conceive under such circumstances that "an incandescent light, even though perfect in all "other respects, could have been made an econo-"mical success as compared with gas or other illumi-"nants.

"The electrical force is now obtained very much "more cheaply by consuming coal in a steam engine, "the mechanical force of the engine being converted "into electrical force by means of the powerful dynamo-"electric machines. Here, too, great activity has "been displayed of late years among inventors in the "improvement of these machines, and the modern 6307
"machines convert mechanical into electrical power "as economically, compared to the older forms, as the "modern turbine wheel compares with the ancient "overshot water wheel in respect to its saving of "energy.

"The dynamo machines all depend upon the prin-"ciple promulgated by Faraday, that when a piece of "metal (as a wire) is moved between the poles of a "magnet (or cuts the field of magnetic force, is its "technical term) a pulse of electricity flows in one "direction while the wire is under the influence of 6308
"the magnet, and returns in the opposite direc-"tion, when it is removed from the sphere of attrac-"tion

6309 "The earlier forms of magneto-electrical machine—
"those of Pixii, Saxton, Clarke and others—consisted
"essentially of a permanent horseshoe magnet of steel,
"in front of the poles of which were two bobbins, or
"spools, of insulated copper wire, wrapped in op-
posite directions on a soft iron core, and mounted
"upon a horizontal axis, which was turned by a handle.
"When the bobbins were revolved the two spools be-
"came alternately magnetized in contrary directions
"under the influence of the magnet, and in each spool
"an induced current was produced, the direction of
6310 "which changed at each half turn."

"A simple improvement, called the "commutator,"
"was soon made, by which the two alternating currents
"were forced to flow into a conducting wire always
"in the same direction. The earlier machines were
"only made to produce feeble and intermittent pulses
"of electricity until the apparatus of Nollet, of Brus-
"sels, constructed in 1850, worked a revolution and
"partially revealed the latent capacities of the prin-
"ciples involved in the apparatus. This machine con-
"sisted of forty powerful horseshoe magnets (capable
6311 "of sustaining 125 pounds weight each,) mounted
"radially on a cast iron frame. On a horizontal axis,
"running through the frame between the poles
"of the magnets, were four wheels, upon whose
"peripheries were placed 64 spools of insulated fine
"copper wire. The wire on all the spools was coiled
"in the same direction, and the spools could be con-
"nected so as to produce at pleasure electricity of
"high potential or of low tenison, just as the different
"cells of a galvanic battery may be connected to
"produce similar variations of electrical condition.
6312 "This machine was run by steam power, and sustained
"an electric arc which measured, photometrically,
"equal to 150 Carcel burners.

"The next degree of advance was made in the pro-
"duction of the Siemens armature, in which the wire

"was wrapped longitudinally on an axis, instead of 6313
"transversely as in the bobbins.

"Then came Wild's machine, which combined the
"Siemens armature with a new principle, that of the
" 'multiplication of the current.' The current in-
"duced in the armature is used to charge a large field-
"magnet (electro-magnet), between the poles of which
"a large Siemens armature was revolved at the rate of
"1,700 revolutions per minute.

"Next came Ladd's modification in which two Sie-
"mens armatures were used, and the permanent mag-
"nets were dispensed with altogether. Mr. Ladd
"found that if the large electro-magnet was once 6314
"charged with electricity from a battery, or other
"source, sufficient residual magnetism remained ever
"afterwards in the soft iron cores to act upon the
"armature and produce a feeble current in it as long as
"it was revolved."

"This current was then passed into the coils of
"wire forming the large field-magnet, increasing its
"strength; this in turn reacted on the armature, and
"so, in a few moments, a very powerful effect was
"produced by the building up, as it were, of succes-
"sive weak impulses." 6315

Other improvements have followed rapidly, such
'as the soft iron ring armature of Gramme, the mod-
'ifications of Wallace and Farmer, the Brush machine
'and latest in point of time, perhaps, is the machine
"of Profs. Thomson and Houston, the patent specifica-
"tions of which were published within a few days
'past."

"Now we come, intelligently I hope, to view the
"machine in Mr. Edison's laboratory, which is the
'fountain head of his electrical power. We are at
"the first glance impressed by the great size of his 6316
"field magnets, standing 4 1-2 feet high, weighing, as
'I was told, upwards of 1,100 pounds. The cores are
"of wrought iron, mounted on heavy blocks of cast

6317 "iron, and joined together at the top by a wrought "iron yoke."

"These cores are wrapped with three layers of No. "10 copper wire, insulated with cotton. The arma- "ture (which it seems to me is identical in principle, "if not in construction, with Siemens,) revolves in the "in the cylindrical space between the cast iron "blocks at about 500 revolutions per minute; there is "the usual commutating axle, with copper wire "brushes for drawing off the electricity.

"The field magnet is "charged" from a separate
6318 "machine, and the amount of electricity poured into it "depends upon the amount of electricity required in "the main line. This is ingeniously and beautifully "accomplished as follows:

"A reflecting galvonometer is placed in the main "circuit, and a small fraction of the current is con- "tinually passing into it, the amount of deflection of "the needle being read by the varying position of a "spot of light travelling over a scale, as in the sub- "marine telegraph system. A series of resistance "coils are placed in the 'local circuit' between the
6319 "charging machine and the field magnet of the gen- "erator proper, and a boy who watches the record on "the scale cuts out or adds resistance by turning "a little wheel, thereby increasing or decreasing the "flow of electricity into the field magnets, thus effect- "ing the flow on the main line just sufficiently to "bring the spot of light back to its normal position. "If the drain on the main conduit is increased "by turning on more lights, the galvonometer indi- "cates the fact instantly, the boy in charge pours "more electricity into the field magnet, the armature
6320 "develops more current, and the engine burns more "coal by reason of the additional mechanical power "required to be converted into additional electrical "power. If we now look at the lamps we will find that

"they are very simple in construction. There is a 6321
"small glass bulb, into the neck of which is intro- "duced a small bulb, containing two platinum wires, "hermetically sealed and terminating inside the lamp "in two little metal clips which hold the delicate "horse-shoe shaped filament of carbonized paper (when "I say delicate I do not mean fragile, for these little "conductors are wonderfully tough and elastic, as I "proved by twisting and breaking several which Mr. "Edison gave me for the purpose of testing their "strength.) The bulb or globe is attached by the "little tube to an exhausting apparatus, which is a 6322
"combination of an ordinary mercury and the Sprengel "pump, and the air is exhausted to the last possible "degree of rarity; the end of the tube from which "the bulb was blown is now sealed with the blow-pipe, "leaving merely a little nipple projecting, and the "whole thing is hermetically closed. The platinum "wires terminate outside the lamp in two metal "springs, which fit into a socket attached to an ordi- "nary gas bracket; by turning a little thumb-screw "the lamp is thrown into the electrical circuit, and the "enormous resistance offered by the bad conductivity "of the carbon horse-shoe, combined with its great in- 6323
"fusibility, accounts satisfactorily for the brilliant in- "candescence which instantly follows. The light is "soft and agreeable to the eye, perfectly steady, and "of a degree of whiteness that depends upon the speci- "fic resistance of each individual carbon horse-shoe; a "great difference being noticed in this respect be- "tween lamps hanging side by side upon the same "circuit. With regard to the intensity of the light, "it is claimed that each lamp is equal to 16 candles, or "to give more light than an ordinary 4 foot burner.
"While it was not in my power to make careful com- 6324
"parative tests, I am not sanguine that such lights as "I saw illuminating the laboratory at Menlo Park

6325 "will be found equal for general illuminating pur-
"poses to an ordinarily good gas burner. The light
"from the best lamps is certainly very bright when
"you *look at it*, but the simplest test of the illumina-
"ting power is to turn your back upon the source of
"light, and look at the space brightened by its influ-
"ence. This trial I found to be an effective check
"upon any rising enthusiasm in regard to the illumi-
"nating value of the light, as compared with a good
"gas burner The difference in this respect between
"the ordinary gas jet, and the carbon horse-shoe
6326 "light seems to me to be tersely expressed in the vulgar
"phrase, that the Edison light is "too thin" *i. e.*,
"while the light from the gas flame proceeds from a
'moderately large quasi-solid body of luminous parti-
"cles of carbon, the light from the carbon horse-shoe
"proceeds from *a very thin filament*; it is as though
"you should cover a gas flame with a little screen
"which would reveal merely a narrow rim of light; of
"course the illuminating power of the gas flame would
"be greatly decreased unless the incandescence of the
"narrow edge could be increased to a corresponding
"degree.

6327 "The machine of Mr. Edison generates a
"current of *very high electromotive force*, i. e., of high
"tension and small quantity; this permits the use of
"small conducting wires. and I confess I was not a
"little surprised to find that the whole current required
"to heat the incandescent lamp could be conveyed
"through a copper wire no thicker than a horse-hair.

"It appears to me that Mr. Edison, while using the
"same materials and similar apparatus to that of his
"predecessors, has in point of fact made quite a new
"departure in the employment of a new form of a
6328 "familiar material which thus offers, *in a short circuit*,
"an enormous resistance (100 ohms) in conjunction with
"a current of sufficiently high tension to overcome
"that resistance with the smallest possible sacrifice of

"power, thus really discovering a new path through 6329
"a field which had already been prospected by numer-
"ous explorers. Whether this "lead" reveal a mine
"or prove to be a mere *ignis-fatuus* I will not venture
"to project."

"The Secretary exhibiting one of Mr. Edison's
"lamps (sent to the Institute by Mr. Addison B.
"Burk) called upon the latter for a few remarks.

"Mr. Burk, in response, said that he feared he
"could add little to the admirably clear description
"of the lamp and generator given by Mr. Outerbridge.
"Having visited Menlo Park several times, however, 6330
"he could say that Mr. Edison had certainly produced
"a lamp fitted, if it should have lasting qualities, to
"take the place of gas.

"At present Mr. Edison is experimenting with
"lamps of different resistances to determine what re-
"sistance is best suited for his purposes. As a result,
"some of the lamps now exhibited give forth a light
"much below and others above the candle-power of a
"gas jet. When the light is dim, the carbon filament
"is of high resistance and appears as a reddish-orange
"line within the globe; but in lamps of low resistance,
"where the carbon is raised to a white heat, the source 6331
"of the light disappears, and the globe appears as a
"ball of fire.

"Prof. Rogers inquired whether the speaker thought
"that the dimness of two lights near the Station, men-
"tioned by Mr. Outerbridge was due to their distance
"from the generators.

"Mr. Burk replied that he thought the distance
'from the generator had nothing to do with it, but
'that these were simply lamps of high resistance.
"Within a few yards of the lamps at the entrance to
'the Park, there is an exceptionally fine lamp. In Mr. 6332
"Upton's parlor some of the lamps close to the gene-
'rator are no better than lamps at a distance. Mr.
"Burk has since ascertained that the real trouble

6333 "with the distant lamps was that the current was fur-
"nished to them through conductors too small for the
"purpose. New lines have been laid, and the most
"distant lamps are now as bright as others of the same
"resistance elsewhere in the circuit.

"In answer to other questions, Mr. Burk said that
"many difficulties had been met with in the manufac-
"turing of the lamps. A record is kept of the life and
"death of each lamp, and inquest held whenever a
"lamp fails. Mr. Edison was recently reported to
"have said that 22 per cent. of the lamps failed. Mr.
6334 "Burk, from his hasty examination of the records,
"judged that there had been fully that many failures
"with lamps, actually put on circuit, while there were
"very many lamps that never got beyond some one or
"other of the stages of manufacture. The causes of
"failure were numerous. Some of the lamps exploded
"or collapsed, probably because they were not strong
"enough to withstand the air pressure. In others, the
"inner bulb cracked after the lamp was lighted. Mr.
"Burk had watched the boys putting the platinum
"wires through the inner bulbs, and had noticed that
"sometimes when the direction of the wires did not
6335 "suit them they would bend them over, thus probably
"putting the glass under strain. When heated under
"such conditions, cracking might be anticipated.
"This accident had occurred to the lamp shown at
"the Institute, in which the inner bulb was cracked in
"a straight line between the two platinum wires as
"they passed through the bulb. Some of the exploded
"lamps left behind them parts of the carbon horse-
"shoe. One of these had been examined by Mr.
"Burk under the microscope. It did not appear very
"different from the carbonized paper before being
6336 "made incandescent, but had a higher lustre—was
"more metallic looking. There was another supposed
"source of failure, and that was the leakage of air
"through the top of the bulb, where it is sealed. Mr.

"Edison had noted the fact that a much larger per- 6337
"centage of the lamps set in fixtures failed than
"of those hung up side down from wires. He there-
"fore examined the seal, and saw, or thought he saw,
"a minute crack. He then examined some of his
"vacuum apparatus, similarly sealed, and found a
"similar supposed defect. Mr. Edison calls all diffi-
"culties "bugs," and this "bug" he got out of his
"lamps by adopting a new method of sealing. Con-
"ceiving that the difficulty might be in making a per-
"fect seal in vacuum, he first sealed the tube as usual,
"and then admitting the air to the sealed tube, sealed 6338
"it again, imprisoning a small globule of air between
"the first and the second sealing, but obtaining clear
"glass around all. He thought that without this
"second sealing (which is done in many different
"ways) the crack which he found in some of his lamps
"might be sufficiently expanded by heat to admit a
"little air to the lamp, and thus destroy the vacuum.

"Doubts had been expressed whether the lights
"furnished by Edison's lamps were equal in practice
"to a gas jet. Mr. Burk thought there was no doubt
"that some of them had a higher, as some had less
"candle-power. He had seen experiments tried in the 6339
"reading of newspapers, which satisfied him on this
"point. There was certainly no difficulty in making
"the carbon give forth a light much greater than a
"gas jet. The whole current had been turned on one
"lamp, (that is, all other lamps had been disconnect-
"ed) and it gave forth the light of many gas jets.
"In Mr. Upton's parlor there is a central light hung
"from the ceiling that illuminates a large room much
"better than the speaker had seen similar rooms in
"Philadelphia lighted by three gas jets. But the best
"evidence that the light was a fair equivalent for that 6340
"of gas was to be found in the fact that sceptics
"visited Menlo Park and came away refusing to be-
"lieve that the lamps had sufficient illuminating

6341 "power to take the place of gas, and yet these same
"sceptics would admit, on cross-examination, that
"they had eaten their suppers at Mrs. Jordan's, at
"Menlo Park, without noticing that the dining-room
"was lighted with two of the Edison's lamps.

"It is well known that the voltaic-arc lamps, giving
"a light of say 2,000 candles, cannot take the place
"of gas jets, having the same candle power in the
"aggregate. The speaker doubted whether these large
"lamps would replace more than one-third of their
"candle power in gas jets well distributed. Mr. Edi-
6342 "son claims that, while he may lose by a division of
"the current in the aggregate candle power obtained
"from a generator, he gains on the other hand by the
"distribution of his smaller lights.

"Prof. Elihu Thomson said:

"There seems to be little doubt that an incandes-
"cence electric lamp of moderate permanency is a
"mechanical possibility. Whether the lamp in ques-
"tion answers all the requirements in this case is of
"course for the future to determine. It would seem,
"indeed, that a consideration of facts long in the pos-
6343 "session of electricians and others, points to the con-
"struction of a practically permanent incandescence
"lamp as a possibility.

"The earlier lamps were short lived: those succeed-
"ing were more lasting. The element of permanency
"seemed to have been gradually introduced, and the
"results claimed by Mr. Edison point in the same
"direction. Whether any new departures have yet
"to be taken to secure a practical, enduring lamp can-
"not as yet be determined.

"The statement has been made and repeated, that
6344 "Mr. Edison was able to *turn the full current* of one
"of his generators on a single lamp without destroying
"it.

"This is altogether an erroneous idea. The state-
"ment should have been that he was able to *take off* all

"the lamps but one from his machine, because from 6345
"the resistance offered by this remaining lamp, only
"such current could flow through it as its conducting
"power would allow.

"The lamp was able to stand the whole electromo-
"tive force of the machine, but not the whole current.
"In other words, the generator, with a single lamp in
"its circuit, did not *produce* more current than the
"lamp could easily stand.

"There is, however, one phase of this subject that
"is vital; that is, success or failure to lighting by in-
"candescence: Does it pay? Can it compete with gas? 6346
"And in this competition gas is to be regarded under
"its most favorable aspects, when most of the leakages
"are below ground and not above. Edison gets eight
"of his lights per horse power; but those who have
"not given attention to the subject will say; 'but when
"all the improvements are made, may not sixteen per
"horse power be obtained'? We say no; it is impos-
"sible to obtain sixteen lights of equal power to the
"eight, even with the best machinery and under the
"most favorable conditions. The reason is that the
"heat-energy given out in the eight lamps, as at pres-
"ent used, nearly equals a horse-power, and we can- 6347
"not recover in the lights more power than we employ;
"not, indeed, more than 60 to 80 per cent. is recovered

"Eight lights per horse-power seem to be all that are
"obtainable without lowering the candle-power of
"each; but then comes the question, assuming eight
"lights per horse-power attainable, what is their
"candle-power? How much light do they give out?
"Opinions differ. Those who have seen the lights at
"Menlo Park, must have been struck by their com-
"parative feebleness. Their average candle-power
"would appear to be from 8 to 10 candles. Taking 6348
"the more liberal estimate, 10 candles, we get in the
"eight lights 80 candles, or 80 candles per horse-

6349 "power. Of course, incandescent lights of any de-
"sired candle-power can be obtained, but an increased "intensity per light means a decreased number per "horse-power. Now, it is easily possible to produce "by the voltaic arc from 800 to 1,000 candles per horse-"power, or over 10 times that obtainable by incandes-"cence.

"Hence, it would seem that the arc must be used in "the lighting of large areas in preference to incandes-"cence, even were the economy of the latter over gas "a proved fact. The cost of carbons in the arc
6350 "lighting is not now of much consequence, as increased
"production has lowered the prices considerably. "There seem, indeed, to be two fields of usefulness "for electric lighting.

"First, where large areas are to be lighted, or where "a powerful white light is needed for special purposes; "the arc light is a demonstrated success, and its "cheapness is a recommendation.

"Second, illumination of small areas, as in house "lighting, to which lighting by incandescence would "seem to be peculiarly adapted, but the success of "which rests on the permanency of the lamp and the
6351 "economy of power consumed, both matters which
"have not as yet been sufficiently determined.

"Prof. Robert E. Rogers had noticed at Menlo "Park the absence of photometric apparatus for de-"termining the illuminating power of the lamps. His "own impression was that the light did not in any "case exceed one-half that given by a gas burner con-"suming five feet of gas per hour.

"Mr. E. Brown had an impression similar to that of "Prof. Rogers. A new lamp which had just been put "in operation did not equal a 5-foot burner: many of
6352 "the lamps were much below that standard. While
"taking supper he did not notice for some time that "the illumination was from electric lamps, one being

"placed at each end of the chandelier, showing that 6353
"the light resembled closely that from gas or oil.

"Mr. Smethurst was of opinion that the light had a "greater illuminating power than an ordinary gas "light, and thought that reading by it was not a re-"liable test.

(Notes following the Proceedings.)

"1. In 1845 an American inventor named Starr "took out in England, through his agent King, a "patent [No. 10,919, dated November 4,] for produc-
"ing light by electricity, which contained, among 6354
"other matter, the following description: "The inven-"tion has for its basis the use of matallic conductors, "or of continuous carbons, heated to whiteness by the "passage of the electric current. The best metal for "this purpose is platinum, the best carbon is retort "carbon. When carbon is employed it is useful on "account of its affinity for oxygen at high tempera-"tures to cover it from air and moisture." Here fol-"lows a description of the figure, which shows a thin "rod or filament of carbon enclosed in a glass vessel.
"The patent then continues: 'A vacuum is previously 6355
"established in the bell, and the apparatus variably "forms a barometer, with one of the poles of the "battery in communication with the column of "mercury and the other with the conductor D.' "The conductor D is represented as sealed directly "into the glass globe or bell, and the reference to the "barometer shows clearly that the vacuum produced "was what is known as the Torricellian vacuum, which, "as far as the absolute exclusion of air or gas, is equal "to anything otherwise attainable; and fully equiva-
"lent for practical purposes, to what Mr. Edison pro- 6356
"duces in his lamps. If, therefore, these lamps are "of any practical use, so also would lamps be if made

6357 "according to the King patent, which is of course, "open to all the world.

"King, or rather Starr, was followed by various in-"ventors and patentees, who modified or improved "the details of his general plan, as Staite & Petrie, "Lodyguyne, Konn, Bouliguine, Fontaine, and more "recently Sawyer. None of these have ever reached "any permanent success in the practical application of "their systems; how far this has been the result of "unfavorable circumstances, and how far it has come "from radical defects in their systems, cannot as yet
6358 "be determined; but it is evident that the ground has "been thoroughly planted with devices and with pat-"ents, from which will spring a fruitful crop of litiga-"tion should any success on the part of one or other "of the closely allied methods make it worth while to "contest the validity of rival claims. *Sanitary* "*Review.*"

2. "At a meeting of the French Academy, held "March 1, 1858, there was received from M. Jobart a "communication in which he speaks as follows:

"I hasten to announce to the Academy the important
6359 "discovery of the dividing of an electric current for "lighting purposes. This current, from a single source, "traverses as many wires as may be desired, and gives "a series of lights ranging from a night lamp to a light-"house lamp.

"The luminous arc between the carbons produces, as "is well known, a very intense, flickering and costly "light. M. de Changy, who is a chemist, mechanician "and physicist, is thoroughly conversant with the latest "discoveries, and has just solved the problem of divid-"ing the electric light.

6360 "In his laboratory, where he has worked alone "for the past six years, I saw a battery of twelve Bunsen "elements producing a constant luminous arc between "two carbons, in a regulator of his own invention—

"this regulator being the most simple and perfect I 6361
"have ever seen. A dozen small miner's lamps were "also in the circuit, and he could, at pleasure, light or "extinguish either one or the other, or all together, "without diminishing or increasing the intensity of the "light through the extinction of the neighboring lamps. "The lamps, which are enclosed in hermetically-sealed "glass tubes, are intended for the lighting of mines in "which there is fire-damp, and for the street lamps, "which would by this system be all lighted or put out "at the same time on the circuits being opened or "closed. The light is as white and pure as Gillert's "gas, with which it has one point in common, namely, 6362
"its production by incandescence of platinum. The "gas pipes are replaced by simple wires, and no ex-"plosions, bad smells or fires can take place.

"The trials that have hitherto been made with the "object of producing electric light by means of heated "platinum have failed on account of the melting of the "wires. This difficulty has been overcome by M. de "Changy's dividing regulator. The cost of the light "is estimated to be half that of gas. A lamp placed "at the masthead of a ship would form a permanent "signal for about six months without the necessity of 6363
"changing the platinum. With several such lights, "placed in tubes of colored glass, it would be easy to "telegraph by night, as they could be extinguished and "relighted rapidly from the deck.

"For lighthouse purposes considerable amplitude "can be given to the light. I also saw a lamp so ar-"ranged in a thick glass globe that it could be im-"mersed to considerable depths without been extin-"guished by any movement. This lamp has already "been used in the taking of fish which were attracted "towards the light. 6364

"The above slight description will suffice to show to "what a variety of applications this discovery can be

6365 "put. The communication which I have had the honor "of laying before the Academy is founded upon no "illusion; a lamp was, to my astonishment, lighted in "the hollow of my hand, and remained alight after I "had put it in my pocket with my hankerchief over it."

90 x-Q. At the time of this meeting the arc-light apparatus developed by yourself and Professor Houston, was being introduced, as I understand you?

A. Yes, the first steps, I believe, for the formation of a company, were about to be taken or had been
6366 taken.

91 x-Q. At the start, did that company do business in any other kind of an electric lamp except the arc lamp?

A. It did not do much business in arc lamps at the start; in fact it did very little business of any account until the company got into the hands of better managers.

92 x-Q. When was this?

A. About 1882—the fall of the year 1882. There
6367 were some few arc lamps put out, but the business was not pushed at all as it should have been.

93 x-Q. No incandescent lamps however, were made and sold by the company up to that time?

A. No, of course not. The arc-lighting business was in very bad shape.

94 x-Q. What was the name of the company up to the time of the change of management?

A. The American Electric Company, of Connec-
6368 ticut.

95 x-Q. Was the name changed; if so to what?

A. Yes, the new management changed the name and 6369
chartered the company under its new name—Thomson-Houston Electric Company.

96 x-Q. Thomson being yourself, as I understand it, and Houston, Prof. Houston.

A. Yes, sir.

97 x-Q. When did the new or Thomson-Houston Company begin to make incandescent lamps?

A. As a regular manufacture, I think about 1885; though I am not sure of this exact date.

6370

98 x-Q. Why did you go into the business of incandescent lighting?

A. You mean myself or the company?

99 x-Q. The company I mean, of course, with which you are connected by interest and by name?

A. The reason outside of other considerations which would be important in answering the question fully was simply that there was business to be done in connection with the establishment of central stations for electric lighting which the company was pushing vig- 6371
orously.

100 x-Q. The incandescent business was an established commercial industry at that time, was it not, and had been established by others?

A. Yes, I believe that a number of companies were making and putting into operation systems of incandescent lighting.

101 x-Q. And the commercial demand for incandescent apparatus was a moving cause in your company's 6372
undertaking the incandescent business.

A. Yes; the demand undoubtedly existed in certain quarters. The cause as a moving cause, was probably

6373 that the company in establishing its plants, which it did oftentimes by expenditure of its own capital, desired to have its stations as complete as possible, taking into consideration all other matters connected with the business. The arc-light plants were supplemented at the start by groups of incandescent lamps distributed on the arc-light circuits and shortly after the series incandescent lamp was put on the same or similar circuits, this development being followed also by the production of lamps for multiple-arc work direct.

6374
Adjourned for lunch at 1 P. M.

Resumed at 2 P. M.

102 x-Q. Were the incandescent lamps put out by your company those of your own design?

A. I cannot say that they were altogether, though I assisted in the arrangements for making them.

103 x-Q. You conducted experiments with a view of producing the types of lamps they wanted, did you
6375 not?

A. Some of the work I watched while in progress, and made some of the experiments.

104 x-Q. When did this work or these experiments begin?

A. I think I made some experiments in incandescent work during the year 1883, but as to actual manufacture I don't think there was much until 1884 or 5.

105 x-Q. When did you first have at your command
6376 facilities for making incandescent lamps?

A. I think it was in the latter part of 1884, though I am not sure that such facilities could be said to exist in any complete shape until perhaps the Spring of

1885. Thinking the matter over, I remember now 6377
that during the Fall of 1884, some lamps were made.

106 x-Q. I call your attention to Letters Patent of the United States, No. 335,158, granted to yourself as assignor to the Thomson-Houston Electric Company, February 2nd, 1886, for incandescent electric lamp. This patent was taken by you was it not?

A. It was.

107 x-Q. Did you ever make such a lamp as that described in the patent just referred to?

A. No; I believe none were made. At the time the 6378
patent was taken there were no facilities.

108 x-Q. At the time you filed this application however, you supposed it practicable to make a lamp of this character?

A. Yes, I do now.

109 x-Q. The patent may be taken so far as it goes, as a fair indication of your theoretical and practical knowledge with regard to the construction of incandescent lamps, may it not? 6379

A. No; it may not; I certainly was quite familiar with such construction. The lamp and patent stands for itself for what it shows; it is a special kind of a lamp, made in a special way for a special purpose. I might say that an inventor in patents is not called upon to more than patent what he considers to be an idea which may be useful and valuable. I do not think that any particular patent can be considered to be a history of what he knows on the subject. It is rather an embodiment of certain things that he may think may possibly be useful, and if those things are 6380
different from what went before or what was known to him before, the patent simply regards these differences.

6381 110 x-Q. Did you ever try to seal into glass by fusion a cone of iron or steel such as the part Y, in the drawing of the patent is described to be. If so, with what success?

A. I have frequently sealed iron wires into glass and I see no difficulty to be met in doing it in the structure referred to. I know that such a joint is apt to leak, but the joint is backed up by a plastic adherent material imprevious to gases, which fills up the conical space above the joints.

6382 111 x-Q. It then becomes practically a cement joint instead of a fused-glass joint, does it not?

A. No, it becomes both a fused-glass joint and a cement joint. I had, long prior to taking this patent, sealed iron wires into glass and made them tight by a plastic substance outside of the joint for holding the vacuum. I have had vessels with a vacuum so preserved for years, the slight tendency to leakage around the iron being checked or prevented by the plastic compound outside from spoiling the vacuum.

6383 112 x-Q. Does your company or any other manufacturer of incandescent lamps, so far as you know, use iron leading-in wires fused into the glass, and if not, why not?

A. They do not, the reason being that platinum has been long known as a material which can be sealed into the glass for holding vacua in all sorts of apparatus and that the platinum used, if it does not form too large an item of expense of the lamp, might cost less to use than to make another form of joint, particularly as this platinum is returnable, or capable of being used again in the construction of new lamps, when the
6384 lamps have been used up or destroyed. It is simply a question of desirability in my mind. Furthermore the placing of the lamp in any position with a plastic

compound outside of the joint is less easy than with 6385
a plain platinum seal.

113 x-Q. That is, platinum has approximately or practically the same co-efficient of expansion as some glass compositions, while iron has not.

A. Yes.

114 x-Q. And the difference in expansion between the iron and the glass, if iron wires are sealed in, would result in a fracture at the points of sealing and the leakage of the lamp if the fusion of the glass upon
the wire were alone depended upon? 6386

A. No, not at all; the iron shrinks more than the glass and relieves the glass of strain, so that it is not liable to fracture, but on the contrary it simply does not fit the hole in the glass so well as platinum when the thing is cold.

115 x-Q. It shrinks away when cold, and leaves an opening around it, is that the idea?

A. Well that would be a very coarse way of expressing it, the opening being hardly detectible by
the high powers of the microscope. The iron simply, 6387
as it were, frees itself from the glass, leaving a crevice which could not be detected, but which after a considerable time might allow the vacuum to be injured. I have found, in fact, that with a fairly long seal in iron it takes quite a long time to run down a vacuum.

116 x-Q. Of course the larger the iron wire, the larger would be the opening when it shrinks?

A. Yes, the larger the leakage, though the opening I think would be scarcely perceptible in any case—
if it can be called an opening. 6388

117 x-Q. Then in the lamp of the patent the reliance for maintaining the seal is upon the plastic cement, is it not?

A. Not exactly; the sealing of the metal in the

6389 glass leaves practically so little to be done that the plastic seal does the rest.

118 x-Q. Did you ever try this process of construction consisting of a conical iron or steel plug running out into a cone of glass, as shown in the patent?

A. No, not that process of construction.

119 x-Q. The method of clamping the carbon in the lamp by setting it simply in carbon cups is one hardly likely to be attended with success in incandescent
6390 lamps, is it?

A. Yes, I think it would succeed admirably and with the structure in question. It must not be forgotten in this connection that the burner B described there is made up of a very spongy, poorly-conducting mass with a skin or exterior formed of highly-conducting carbon; that this gives virtually a thin, highly conducting tube of carbon. Now the ends of the carbon are inserted into carbon cups and fitted closely thereto and a certain pressure exerted thereon. The fact that the cups are large, comparatively, will take
6391 away heat, the surface contact being also large comparatively; but even if this joint be considered imperfect I would call attention to the fact that it was well known at the time of the patent that carbon pieces in juxtapositition could be joined by simple putting in a sugar syrup on the joint which will carbonize at high temperatures and connect the two. This junction of carbon pieces was I believe known as far back as 1880, as I recollect it now.

120 x-Q. Where do you find much a junction referred to in the literature on the subject?
6392 A. If I am rihht in my recollection it is an arc lamp patent, a magazine of carbons being fed down and the junction between successive ends of rods made by inserting carbonizable cement.

121 x-Q. Have you used a joint of the kind shown 6393
in this patent yourself in any of your commercial incandescent lamps?

A. No, I think not.

122 x-Q. Do you know any other commercial incandescent lamp having such a joint?

A. No, I think there are none; at least I am not aware of them. I would say that there are very much better methods of making the joints known to-day, and that most of the lamp-joints are made by these better methods.
6394

123 x-Q. Is it not a fact that this patent of yours shows on the whole, judging from the evidence which the patent itself furnishes, a very imperfect knowledge of the practical requirements involved in the construction of incandescent electric lamps?

A. No, I cannot agree with that statement. The patent simply shows what I have said before—certain ideas which are useful supposedly, have been recorded in the patent. In so far as it does not record anything, it simply is negative. In so far as it does show novelty of any kind it is useful for the purpose of the 6395
patent. The inventor frequently takes ideas which occur to him which are different from others, either known or which he may embody in a different application, and puts them together. It is sufficient for the purpose of the patent if they are different. The patent, however, must stand on its ability to show a working device, and I still hold that this lamp is a working lamp. This is a special lamp intended only for series work, and, as one of its peculiarities—and this accounts for its peculiarities—it embodies a shunting contrivance for keeping the circuit intact in case of failure 6396
of the carbon conductor. Such devices for closing the circuit are requirements in the operation of series lamps, and this I believe is the first lamp which shows such

6397 devices, and the whole structure, in fact, is built around that one function of shunting or keeping the circuit intact when the carbon breaks.

124 x-Q. Returning again to the sealing of iron or steel conductors into glass, am I right in my recollection that you have stated in substance that while with the platinum the fusion of the glass upon the wire would be all that is necessary, yet with the iron or steel conductor the body of plastic material around the wire where it enters the glass would be needed to
6398 insure the maintenance of the vacuum?

A. No, I have not said that. In fact it may be possible to find a glass which has the same co-efficient of expansion as iron; some of the glasses having large amounts of metallic oxide are much more expansible than the ordinary glasses, and I do not wish it to be understood that I in any way limit my conception of the possibilities of iron in this direction. I do say, however, that where such a seal might leak slightly, the plastic composition, by filling the leak and inserting itself in the gap or crevice, will stop that leak, especially if the plastic composition is non-vapori-
6339 zable itself.

125 x-Q. I do not refer to the possibilities, but to our knowledge of the subject as we possess it at the present time; in making a seal with iron wires as we know the facts at the present time, would you consider it essential to use a plastic cement in connection with the seal in order to make certain the maintenance of the vacuum?

A. If a short seal be used with ordinary glass, I should say yes; that such a plastic cement might be
6400 needed. I have not experimented to find out how long a seal with iron could be made which would be tight or practically so for the uses to which it is to be put.

126 x-Q. So that so far as your experience has gone 6401
such a plastic cement would be necessary?

A. So far as my actual experimental trials go, I think that it would be necessary; though I can readily see, as I have said before, that it would be a mere matter of judgment in selection of materials to secure a glass which expanded at the same rate as iron, assuming it could be got.

127 x-Q. I may take it that you have not yourself discovered a glass composition which will fulfill these conditions?

A. I decline to state what I have discovered in this 6402
particular. This would be a question outside of the limits of this cross-examination, in my judgment. I will freely say, however, that the ordinary glasses are not to be expected to have this peculiarity.

128 x-Q. I will put it differently then. You have not discovered and announced to the world, by publication or otherwise, a glass composition which would answer these conditions?

A. That is true without question.

Counsel for complainant offers in evidence the 6403
United States Patent granted to the witness and referred to in the last few questions and answers, and the same is marked "Complainant's Exhibit, Thomson's Incandescent Lamp Patent, No. 335,158."

129 x-Q. I call your attention to U. S. Patent, No. 335,160, granted February 2, 1886, to yourself as assignor to the Thomson-Houston Electric Company for Incandescent Electric Lamp. Is this your patent?

A. Yes. 6404

130 x-Q. Have you ever practically used the method of sealing iron wires into glass, described in

6405 this patent ?

A. No, for the same reason I stated before, in my previous answer, where the conical iron or steel wire is referred to.

131 x-Q. Or platinum wires ?

A. My recollection is that I made several seals with platinum wire and the fine glass admixture. I have no recollection about iron in this connection, though it is possible some joints were made with iron.

6406

132 x-Q. In connection with the use of iron wires in the structure described in this patent, do you find in the patent any description of, or provision for, the use of a plastic cement to protect the seal ?

A. No; the object there was to have the seal made up of a material of average expansibility similar to that of the wire, and shaded off into the glass body, while shaping the seals accordingly, just as sometimes wires have been surrounded with glass rich in metallic oxides, and this glass shaded off into the body of the
6407 lamp—a procedure that was known even in the Geissler-tube manufacture; that is, a fusible, expansible glass surrounds the wire intimately, and this expansible glass is united to the other glass. I had hoped by this method to produce an averaging of expansibility which would permit the iron wire to be used in effecting the seal. As I have said before, the platinum, being known to hold a vacuum in all kinds of vacuum apparatus, has been used in preference.

133 x-Q. Have you ever used and practiced the resistance-equalizing clip, described and referred to in
6408 the fourth and fifth claims of this patent?

A. Not in actual practice, though experimentally I have.

134 x-Q. Have any of the lamps which have been 6409
made and sold for regular commercial purposes by your company been made in accordance with this patent?

A. No, I believe not.

The patent referred to in the last few questions and answers is offered in evidence by counsel for the complainant, and the same is marked "Complainant's Exhibit. Thomson's Incandescent Lamp Patent, No. 335,160."

6410

135 x-Q. Have any other patents been granted to you for incandescent electric lamps or features involved in the construction of such lamps?

A. I do not think I can answer that question without looking up the patents. I call to mind none which relate especially to the formation of the lamp itself.

136 x-Q. Referring to your answer to 2½ Q., what was the character of apparatus upon which you were awarded the Grand Prix at the Paris Exposition
last year? 6411

A. On an exhibit of apparatus at the Paris Exposition covering quite a wide range, and I suppose the whole of it. I have no recollection of any special apparatus in this collection having been selected for the recognition. The apparatus was electrical, and so far as I know, the award was given simply for my electrical inventions.

137 x-Q. In answer to question 6, you state that you have never known lamps having been made or 6412
introduced commercially which were constructed like the lamp described in the specification and shown in the drawing of the patent in suit, to what parti-

6413 is, what is the lamp which you understood you were limited to by the question?

cular features of construction described in the patent in suit and shown in the drawing do you refer; that

A. I understood the lamp to be one made in accordance with the steps given for its production in the specification. One, in other words, in which there is a coiled carbon, coiled on account of the limitation of radiating surface secured thereby, or coiled to an extent to so limit the radiating surface; one in which the carbonization of the burner is made subsequent
6414 to the attachment to the wires, or, in other words, after the conditions of the carbon are set and incapable of change; one in which the burner itself is constructed of a compound of tar and lamp-black, called tar-putty, or in which the thread is stuck to the wires by tar-putty and afterwards carbonized; and one in which the mounting of the carbon so made is followed by the sealing of the glass globe over it and and exhaustion without any treatment whatever given to the lamp to further perfect it. In short, I mean a lamp made in accordance with the instructions for making
6415 given in the specification, as I understand it.

138 x-Q. In fact you had in mind the same features of construction, and the omission of the same precautions or processes, which you criticise at length as impracticable in your answer to the 8th question?

A. Yes, I have in my answer to the 8th question specified more fully in what particulars I regard the lamp to fail, it being supposed that the specification is followed in the production of the lamp, which was intended to be a serviceable lamp.

6416

139 x-Q. Is the subsequent treatment you refer to the heating of the carbon burner to incandescence by an electric current while the lamp is in a condition of

exhaustion, or is being exhausted? 6417

A. In part it is, though I do not think this would be alone sufficient. The heating of the joints would be quite important, as they would gradually evolve gas and tend to run down the vacuum. This heating could hardly be carried out fully without special arrangements not mentioned in the patent. I also referred, in general, to consolidation of the carbon, or rather to the removal of gases from the carbon, from its joints and from the glass vessel itself. I admit this procedure in getting high vacua was not an unknown method.

6418

140 x-Q. That is, a skilful electrician and physicist would have employed these methods and secured the more perfect results without instruction to do so by the patent?

A. No, not exactly. The difficulty with the gas in the joints would still remain, as the physicist could not be expected to deal with that difficulty; but I think it may be fairly stated that the skilful electrician or physicist would get the lamp-bulb hot, and probably heat the carbon by the current. The speci- 6419
fication however, is silent on this step in the process, and my remarks relate to the specification.

141 x-Q. That is, in passing opinion upon the practicability of the lamp described and shown in the patent, you assumed a lamp which was made by precisely following the description of the patent and omitting to supplement it by good skill and judgment; am I right?

A. I answered the question put to me on the direct examination as I understood it. I did not infer any- 6420
thing in relation to the matter; I simply took the specification as I found it. So far as skill and judgment go, I understand perfectly that differences in the

6421 structure of a lamp may be introduced by the use of extra skill and good judgment, which is true of the King lamp and others to which I have referred in comparing the lamp of the patent.

142 x-Q. Am I correct in understanding your last answer to be in substance an affirmative answer to my last question?

A. No, you are not quite right. I hold that the order of procedure as laid down in the specification is wrong for producing a good result. I particularly
6422 criticize the carbonization at that stage in the process after the attachment to the wires. If the question relates only to that portion of the operation which consists in exhausting the lamp by having the lamp hot, then I would say, yes.

143 x-Q. That is to say, that so far as your criticism extended to those imperfections which would result from omitting to heat the carbon by an electric current while the lamp is being exhausted, you follow-
6423 ed the precise language of the patent and did not supplement it by good skill and judgment.

A. I followed the process laid down in the patent, and did not add anything to it. Whether this would be added by skill and judgment is a matter of opinion. In my opinion the heating of the bulb and the carbon during exhaustion would have been such a thing as would have been suggested by proper skill and judgment.

144 x-Q. The heating of the carbon and of the bulb for the purpose of driving the air and gas out of the
6424 burner and the surrounding parts, was a process known at the date of the application for the patent in suit, was it not?

A. Substantially, I think, yes. In a general way 6425
it was perfectly well known that the highest vacua were only obtainable by driving off and expanding the gases which adhere to objects exposed to the vacuous space. This was, I believe, done in the making of Crookes tubes.

145 x-Q. It was also known for incandescent lamps was it not?

A. I think the Sawyer-Man lamp was dealt with in substantially that way for removing oxidizing gases.

6426

146 x-Q. The process being described in the Sawyer-Man Patents Nos. 210,809 and 211,262, both granted before the application for the patent in suit?

A. Yes.

147 x-Q. Did you read through the French patent of Mr. Edison referred to on your direct before making the statement you did about it?

A. I don't think I read it completely; I read a portion of it. There is a great deal in it and of a mixed character.

6427

148 x-Q. I call your attention to that patent and ask you if you do not find this same process described in connection with his platinum lamp and also referred to as being suitable for use with carbon?

A. Yes, I find it there.

149 x-Q. In your answers to questions 6, 7 and 8 did you make the coiling of the carbon filament a necessary feature of the lamp upon which you based your opinion?

A. I dealt with it as a feature of the lamp discribed 6428
in the specification, and criticised the coiling along with other features in the lamp.

6429 150 x-Q. Now, as a matter of fact, the old form of incandescent lamps described in the literature upon the subject had burners which were coiled and also burners which had various other forms including straight burners, arched burners, and the like: is that so?

A. Those described as made of platinum wire were generally shown coiled or spoken of as coiled: Those of carbon were generally shown in the straight or bent form. I do not call to mind any incandescent lamp with a coiled carbon, and in that respect the invention
6430 in suit is different from what I know of the art before. I do not call to mind any lamp with the coiling so close as to very much restrict the radiating surface, and in that respect the lamp of the patent in suit is novel and different. I have not made a special search for matters of this kind, but I give my impressions as they exist.

151 x-Q. You do not recollect that the very first incandescent lamp which we have any record of, namely, that of Grove, had for a burner a coil of plat-
6431 inum, the spirals of which as described by Grove himself in 1845 were "as nearly approximated as possible, as each aids by its heat that of its neighbor, or rather diminishes the cooling effect of the gaseous atmosphere." And you do not also recollect that in the French patent taken by George and Delaloge in 1851 the coils were brought as close together as possible so as to reduce the radiating suface and conserve the heat of the wire?

A. I believe I have been familiar with the first ref-
6432 erence; the second is new to me. The first reference however, to Grove, I do not consider as meeting the point in issue. I can readily see that the restriction of convection can occur without much restriction of

radiation. In other words, air currents themselves 6433
may be restricted as to the heat-carrying power while the radiation is practically free. In a vacuum, the convection is but a small or almost imperceptible factor. The other reference seems to meet the point more closely, and I should say that it would modify my opinion as to the novelty of the coiling for restricted radiation.

152 x-Q. Irrespective then of the material of which the burner is made, this spiral form as well as plain forms of the burner—that is, straight or bent burners 6434
—were old before the date of the patent in suit?

A. Yes, the spiral form was old as well as the other form.

153 x-Q. What do you understand by the following statement made in the patent in suit with regard to the coiling of the carbon filament: "By using a considerable length of carbon wire and coiling it, the exterior which is only a small portion of its entire surface will form the principal radiating surface; hence, I am able to raise the specific heat of the whole of the 6435
carbon, and thus prevent the rapid reception and disappearance of the light which on a plain wire is prejudicial, as it shows the least unsteadiness of the current by the flickering of the light; but if the current is steady the defect does not show."

A. I understand by that statement that there is given a character to the lamp which makes it superior to others for general use. The statement evidently relates to the fact that by coiling there is obtained, in addition to the other advantages which are stated to be obtained by coiling, a last advantage that in case of 6436
unsteadiness of current, the heat being retained during the fluctuations, tends to steadiness; the phrase "raise

6437 the specific heat" is not an accurate phrase, because there can be no such thing as raising the specific heat in this case. What is there meant, I suppose, is to raise the temperature obtainable with a given lower current and diminish the loss of heat, or diminish the rate of loss of heat, by radiation. I find in the patent, in fact, that the specification starts out with the statement: "The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight
6438 surface from which radiation can take place." The paragraph quoted in the question appears to me to be simply a further statement of an advantage which the lamp has over others, and it is made, in my opinion, largely on account of the fact that the currents producable were a litle shaky or subject to variation, which variations were diminished in their effect on the light by the lamp in question. This interpretation appears to me to be followed out in the instructions given for producing the coiled form as in the paragraph beginning line 37 page 2: "if the carbon
6439 thread is liable to be distroyed during carbonization, it is to be coiled between a helix of coppor wire," etc.; and in the next succeeding paragraph which states that "with substances which are not greatly distorted in carbonizing they may be coated with a non-conducting, non-carbonizable substance which allows one coil or turn of the carbon to rest upon and be supported by the other." The drawings show the lamp in its completed state with the carbon conductor coiled, no other form being shown.

6440 154 x-Q. Is it not clear from the statement of the patent in suit which is quoted in my last question, that the patentee's idea was that the coiling of the carbon filament would prevent or lessen the flicker of the

light when the lamp was used with an unsteady cur- 6441
rent?

A. Yes, I think that was the meaning intended to be conveyed by the paragraph.

155 x-Q. This flicker, the patentee says, would be prejudicial on a plain wire but if the current is steady he says the defect does not show, does not this mean that the defect would not show on a plain wire, that is, one not coiled, if the current were steady?

A. Yes.

156 x-Q. So that, so far as the securing of this object 6442
goes, the patent clearly contemplates that a plain or uncoiled burner might be used and still not be subject to the objection of flickering if the current were steady?

A. I really don't know that it does so contemplate; and reading the statement of invention on page 1 between lines 14 and 18 inclusive, would seem to take away the force of the statement in question. From the fact that incandescent lamps have been made, and are made, with the plain wire or conductor at this
date, it seems to me more easy to read such contem- 6443
plation in the patent than it would have been at the date of its issue.

157 x-Q. The statement that even a cotton thread properly carbonized, etc., will offer a certain resistance while if the thread be coiled it will offer a certain other resistance, which is made in the patent, indicates does it not, that the first form mentioned is not the coiled form?

A. I really don't know. No statement is made of
using the cotton thread in the lamp except to say that 6444
it is stable at very high temperatures. Where the question of radiating surface comes in, the thread is

6445 said to be coiled; that is, the statement that as much as 2,000 ohms resistance may be obtained without presenting a radiating surface greater than 3/16ths of an inch. It is possible of course that the first reference to a carbon thread properly carbonized may mean that it is to be used as a source or light. but much greater stress being laid upon it, preparation in the form of a coil and the statement of invention with the advantages just discussed, lead me to think that in any case the coiled form is to be regarded as an important feature of the invention. I am really unable to say
6446 what the specification does mean outside of it.

158 x-Q. That is, you think the coiled form is preferred by the patent.

A. I think the coiled form is made a very important feature of the invention. preferred or not I do not know. It is certainly preferred as the form which is to be used.

159 x-Q Is it not a reasonable construction of the language that the first cotton thread spoken of is to
6447 be an uncoiled or plain thread in view of the fact that immediately afterwards the cotton thread is described as having a higher resistance when coiled?

A. I do not know; no form is given to the thread in the first instance; no length either.

160 x-Q. That is, its form may be anything except the coiled form against which it is distinguished by the succeeding statement in the patent?

A. Yes, it may be anything perhaps; if it is to accord with the statement of invention, it must offer a
6448 great resistance and at the same time present but a slight surface from which radiation can take place. I suppose it could be doubled up in some form or other to do that and not be coiled.

161 x-Q. You may omit from consideration the 6449
statement of invention. The relations between the different parts of the patent will be determined by the Court. I ask you simply with regard to this statement in the specification which says that when a cotton thread is properly carbonized, etc., it will offer from one to five hundred ohms resistance, and that when coiled it will offer as much as two thousand ohms resistance; now as a fair construction of that language is not the first cotton thread spoken of not to be coiled while the second one is?

A. As there is no length given to the thread in 6450
either case, if it is to be the same thread I should say it must be shorter in the first case than in the latter case, but what form is to be given to it I cannot tell; there is nothing said about it. Of course I cannot conceive that the same thread in the coiled form would give a different resistance from an equal length in a straight or bent form. It may be possible that an explanation for the passage may be found in the fact that one hundred to five hundred ohms may not be considered as much as was desirable in this particular case, and that the coiling was adopted as an expedient for obtaining quite high resistance. So far as stating 6451
what the form of the thread is to be, or in what way it shall be put into the lamp, or what direction it is to take in the lamp, as there is nothing said about it outside of the coiling, I am at loss to find in the specification anything which clears the matter up. I am quite willing to admit, however, that the passage may refer to a plain thread arranged in some way; only I do not find that statement in the specification.

Adjourned at 4.45 P. M. to Tuesday, February, 18th, 1890, at 11 A. M.

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6453 BOSTON, MASS., Feb. 18th, 1890.

Met pursuant to adjournment.

Counsel present as before.

162 x-Q. I did not ask you by the last question to find that any specific shape was described as being given to the first cotton-thread carbon, but only that you should exclude one shape, namely the coiled shape, as that used for the first cotton-thread carbon. Is it
6454 not the fair interpretation of the language that the first cotton-thread carbon was not to be coiled, while the second was?

A. I consider that the statement, if it stood alone, unconnected with any other portion of the specification, might have such an interpretation, but at the very best it would be an extremely vague and unsatisfactory statement as indicating anything of the kind. From the fact, however, that the patent is particular in setting forth the feature of limited radiation, and also in setting forth the manner of procedure to be adopted in carbonizing the coil, I can only regard the
6455 statement as a sort of explanatory clause, laying down the results of experiments which finally lead up to the coiling as a part of the lamp. I cannot regard the statement in paragraph beginning with line 60 as a description of the lamp proper. It is, so far as I can see, nothing more than an explanation of certain steps discovered during the process of producing the lamp which is afterwards described. The second, third fourth and fifth paragraphs of this specification state what the invention consists of, after which follows a paragraph relating to the prior art. Then comes a
6456 statement of experiments or investigations, and subsequently to this I find the lamp described. If the cotton thread which is not coiled is to be taken as a part of the lamp structure, or a part of a lamp

structure, it is certainly not so stated in the specification; and furthermore the coiling is but one form into which the carbon conductor could be put for restricting its radiating surface, the coiling, perhaps, being the best form or the one most readily constructed, for securing that result. I think, therefore, I am quite right in saying that I find no indication in the specification, in the portion to which my attention has been distinctly drawn, of what the form is to be or that it is to be a plain, uncoiled thread, without restricted radiating surface. 6459 6460

163 x-Q. We will take up your reasons separately; is not the first cotton-thread carbon described as being mounted in an exhausted, glass receiver with a capacity to pass a current through it when so mounted?

A. Yes, the thread throughout is supposed to be so mounted; but I do not find in that any indication of the fact of its being used as an illuminant or that it was anything more than an experiment indicating the 6461
line of procedure in making the invention which is afterwards described.

164 x-Q. Does not the patent, in stating that when the thread so mounted would be stable at very high temperatures, indicate that it was to be brought up to a light-giving incandescence.

A. It simply indicates that this was a property of thread so mounted, to stand the high temperature of incandescence in a vacuum, and of course to do that 6462
it must be mounted and the current passed through it.

165 x-Q. Is not the statement in connection with this first cotton-thread carbon that it is to be "properly carbonized and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere" and that when so placed it "offers from 100 to 500 ohms resistance to the passage of the current, and that it is

6463 absolutely stable at very high temperatures" a good general description of the lamp structure which is more specifically described at other points of the specification?

A. So far as I can see, it is nothing more or less than the statement of a property of carbon thread heated in a vacuous chamber. There is nothing said about how it shall be placed at this point, or how it shall be mounted. There is nothing said about how it shall be
6464 arranged. We have to look further in the specification for any indications of this kind, and when we reach them we find that specific instructions are given as to, not only the arrangement of the conductor in the coil form for specific reasons, but processes or methods of producing the coil and carbonizing the same are distinctly set out, the figures of this patent being devoted to this particular also with the others. I have my doubts whether the specification, in making the
6465 statement that the thread gives from 100 to 500 ohms resistance may be taken as indicating that that resistance is enough; but on the contrary, the specification seems to indicate that that is not enough, or at least was not regarded as quite enough, and the spiral form was selected as the form giving a higher resistance, adapting the lamp for multiple-arc distribution. I am borne out in this opinion by the fact that in describing the platinum lamp it is stated to have 750 ohms resistance, which adapts it to use in multiple-arc distribution. I therefore regard the passage in
6466 question as little more than a general statement of a property, or of an experiment discovering a property, which is afterwards made use of in the structure of the lamp proper when the thread is coiled. At all events the statement must be admitted to be an extremely vague and indefinite way of indicating that lamps are to be made without coiling, and the statement standing alone certainly indicates just as

well that the thread might be disposed of otherwise than in the form of a coil for giving restricted radiation. 6467

166 x-Q. How much of the specification of the patent in suit do you consider is descriptive of experiments?

A. The preliminary portions of the paragraphs which lead up to the finally-adopted form seem to me to be statements of experiments. The paragraph beginning 6468
line 60 starts out with statements of experiments, discovery of properties, and ends by describing how these properties may be utilized in the construction of a lamp. The lamp is not distinctly described until the latter part of the specification. The first part of the paragraph, beginning line 98, page 1, seems to me to begin with a statement of experiments, and then goes on to state a discovery which is used in the making of the lamp; that is, the union with the wires, the clamping being regarded as an experiment not giving or 6469
yielding satisfactory results. After these paragraphs, the matter is more descriptive of the actual lamp shown in the figures; the methods of producing the carbon spiral and the properties of the spiral are distinctly set out.

167 x-Q. Considering the matter beginning with the statement "I have reversed this practice. I have discovered" etc., and ending with the same paragraph in the words "the spiral after carbonization retaining its form"; do you consider all this matter as statement of 6470
experiments; if not, where do you make the distinction?

A. It is in my opinion a statement of experiments together with the results of experiments; that is, the discovery of certain properties and a statement of the way in which the inventor proposed to make use of those properties. This would be the natural order in

6471 any case. The statement "I have discovered that even a cotton thread properly carbonized" etc., seems to me to be a statement of what had been found by an experimental trial. This is followed by the statement that "if the thread be coiled as a spiral and carbonized or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber, be so coiled, as much as 2,000 ohms resistance may be obtained without presenting a radiating surface greater than three-sixteenths of an inch;" and I regard this
6472 as a refining of the experiment or the discovery of further facts leading to the construction of the lamp, since in this case the feature of radiating surface comes in in addition to the other features pointed out. Then follows a statement of certain experimental operations, leading further to other conclusions which are made use of. The whole paragraph seems to me to be a statement of results obtained by experiment, beginning with the simpler statements, and ending with those which are made use of in the construction of the lamp;
6473 in other words, the laying down of principles and the following out of principles. The paragraph concludes with the words "the same may be coated with a non-conducting non-carbonizing substance and wound on a bobbin, or as a spiral and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form." This refers to the forms that are to be given to the tar-putty, and no other form is suggested than the winding on a bobbin and the winding in a spiral. In fact, even after the
6474 paragraph mentioned, the statements are of a similar nature, finally leading up to the completed embodiment of the principles laid down in these paragraphs.

168 x-Q. Your idea is then that both of the statements with respect to the cotton-thread carbons in this paragraph are statements of experimental results?

A. Certainly, one being supplementary to the other as made use of in the lamp structure.

169 x-Q. Let us then for the moment consider it in 6475
the light of a statement of experiments. The patent first states that if cotton thread is properly carbonized etc., it will have a certain resistance, and then if a cotton thread be coiled as a spiral and carbonized, it will have a certain higher resistance and will present a definitely small radiating surface, notwithstanding its high resistance. Does not this mean that notwithstanding the greater length given to the second carbon it may by coiling be made to present a small radiating surface? 6476

A. As nothing is said about the length in the specification, the inference would naturally be that when the higher resistance was mentioned, a greater length of thread was involved. There is no doubt that by coiling the carbon close together as a close spiral, its radiating surface would be lessened, as stated; and this appears to me to be one of the objects of invention of the patent as distinctly set out in several places in the specification. Nothing is said of the form or arrangement of the carbon when it has the lower resist- 6477
ance, and if it were arranged to present a limited radiating surface when it had the lower resistance by bending it or forming it in various ways, it would be natural that, if the radiating surface so presented could best be adjusted when the carbon was in the form of a coil and that if more of the carbon could be brought together in the form of a coil than in other forms, that the statement should be made as it is made, and the coiling described as the form for use.

170 x-Q. Is it not a fair inference that the descrip- 6478
tion of these two cotton-thread carbons—take it as a description of an experiment if you see fit—means that the second cotton-thread carbon, notwithstanding its greater length and higher resistance, may by coiling be brought to approximately the same radiating surface as the first cotton-thread carbon in a plain form; that is to say, that the two statements by fair inference may

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be taken to refer to carbons of the same or approximately the same candle power and radiating surface—one, the second, however, having much higher resistance than the first?

A. I think the assumption in the question is a great deal to base upon so slight a statement as is found in the specification. Of course it is easy to assume or, infer many things, but the specification does not give in my opinion, any warrant for these inferences now
5480 made. It says nothing about the same candle power, nor does it say anything about the extent of radiating surface in the first instance, and if the inference is to be made it will have to be made in my opinion as a pure gratuity, and as an amendment to the specification involving matter which ought to have been presented there in a form capable of being understood without these inferences. I have understood the specification as I have stated, to indicate certain properties of cotton thread carbonized in the one case,
6481 and certain properties secured by coiling in the other case. The view taken in the question is altogether new to me, and one which I do not think could have been understood as a natural inference at the time the patent was taken out, even assuming that the statement had been much clearer than it is. The fact that the coiling turned out to be a disadvantage, and that incandescent lamps in actual practice were made without it—that is, with a plain conductor whose surface was practically free in all directions for radiation—
6482 might give foundation for this inference now, or at least might give a certain plausibility to the inference, but I fail to discover that there is any real warrant for it when we take the statements of the specifications alone into consideration.

171 x-Q. I would not expect you to admit the correctness of the assumption I am about to make, so I will ask you to assume that the object of the patentee

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was to produce a sub-divided or small electric light comparable in candle power to an ordinary domestic gas jet, and that in the statements contained in the specification, the patentee refers to such a light, and not to lights of widely varying candle powers. Please make this assumption. You may also assume—I do not ask you to admit it—that the two cotton threads referred to are threads of the same diameter, taken off from the same spool which the patentee had in front of him at the time of making what you see fit to call these 6484
experiments. You may assume—I do not ask you to admit it—that the two pieces of cotton thread will be carbonized to the same degree, and after carbonization will offer the same resistance for equal lengths. Now, is it not a fact that under these assumptions, the thread having from one to five hundred ohms resistance will be proportionately shorter than the thread having two thousand ohms resistance; that is, if it has one hundred ohms resistance, it will be one-twentieth the length of the second thread; if it has five hundred 6485
ohms resistance it will be one-fourth the length of the second thread?

A. Yes, I had made the assumptions myself in giving my former answers, and come to the conclusion pointed out that the first piece of thread must have been much shorter than the other.

172 x-Q. Carrying forward these same assumptions, and the further assumption which I would not expect you to admit, that the two cotton-thread carbons are 6486
brought to approximately the same degree of heat by the passage of the current, would there not be a very great and wide difference in the candle power of the two lamps if both the cotton-thread carbons were coiled in the same way so as to largely restrict the effective radiating surface?

A. If they were arranged so as to restrict the radi-

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ating surface, to the same comparative degree, there would be a large difference in candle power.

173 x-Q. What would be the difference in candle power under these circumstances?

A. Making the assumption that the coiling in both cases gave an equal restriction or, in other words, permitted the average incandescence of any portion of the total surface of the thread in one case to be the same as the average radiation from an equal portion of the
6488 surface in the other case, the difference in candle power with the same temperature would be in the ratio of their resistances, assuming again that the resistances are hot resistances or resistances during operation.

174 x-Q. That is to say, the first cotton thread, if having a length to give it one hundred ohms, would, under these assumptions, produce a light of only one-twentieth of that given by the second cotton thread,
6489 while, if it had a length to give it five hundred ohms resistance, it would give a light equal to one-fourth the second cotton thread?

A. Yes, and it is this fact which makes me unable to admit the proposition put forth that a variability of one to five is given in one instance where I am expected to assume the thread is plain, and in the other case, when it is in the form of a spiral, the resistance is put down at a definite amount.

175 x-Q. What is the proposition you cannot assent
6490 to which you refer in your last answer?

A. Simply this: That in the one case of the thread being mentioned without any statement as to what form or what arrangement it has, the resistance is said to be from one to five hundred ohms; that is, nothing definite. If this is to be the same as the thread with two thousand ohms when coiled, that is, to give the

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same light, then manifestly the thread at one hundred ohms must be differently arranged from the thread at five hundred ohms giving the same light. This is just the kernel of the difficulty which presents itself to my mind in making any of the assumptions which have been the subject of a number of former questions. I assumed throughout, myself, that the thread was the same and that it was carbonized in the same way; and from the fact that in one instance one hundred ohms is mentioned and in another five hundred, I thought 6490
there must certainly be some difference in the arrangement as to radiation if it was a warrantable assumption that equal candle power was supposed to be emitted. It is this absolute indefiniteness of statement which makes me consider the first statement as merely a statement of a property.

176 x-Q. Then you are now ready to concede that if lights of approximately the same candle power are referred to, the arrangements or shapes of the carbon conductors are to be different? 6491

A. No, I simply indicated that I did know anything about it from the specification. Of course I do concede as a general fact outside of the specification that restriction of radiating surface by coiling or by giving other forms to the carbon might permit the use of varying resistances of the same kind of carbon conductor, that is, varying lengths of the same, for obtaining the same light, but that the specification indicates this or means to indicate it, I find no warrant for assuming. It seems to me it would be purely gratuitous to make the as- 6492
sumption that that is what is meant and it would only emphasize the fact that the specification was very incomplete in this particular.

177 x-Q. In reaching the conclusion, however, that the first cotton thread is to be coiled like the second, it becomes a necessary assumption, does it not, that the two lamps contemplated are to have widely different candle powers?

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A. I never reached the conclusion that the first
statement means coiling as does the second, else why
should there be any statements subsequent to the five
hundred ohms statement specifically as to coiling?
Neither have I assumed anything as to candle power
in this connection. I simply say that the specification
is a dead letter on this point and it is a pure gratuity
to make any such assumption in connection with the
matter in discussion. I pointed out the logical con-
6494 sequences of making the assumption that the first state-
ment related to plain carbon thread of a certain candle
power, and that the second statement related to a coiled
thread or one with restricted radiating surface, and as-
sumed the thread to be standard, and showed that the
statement "from one to five hundred ohms resistance"
could not be taken as indicating anything definite except
that the cotton thread had a high resistance when carbon-
ized. That it relates to a lamp with a definite arrange-
ment of the carbon is denied by the very fact of the
6495 statement "from one to five hundred ohms resistance."

178 x-Q. Your present attitude then is, that the first
cotton thread is not necessarily to be coiled as is the
second to be, by definite statement?

A. I have no attitude on the question; anything may
be done with it. I say the specification is a dead
letter on the point. I regard the statement as merely
a statement of a property of cotton thread carbonized,
and if I am expected to import anything into the state-
ment, it must be a pure assumption on my part.

6496 179 x-Q. And this is a property which the cotton
thread carbon would have even in a plain or uncoiled
shape?

A. Oh, certainly, the carbonized thread would have
a specifically high resistance in any shape.

180 x-Q. If at the date of the patent in suit you had
been told in detail to manufacture an incandescent lamp
having an exhausted glass bulb entirely of glass and

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sealed at all points by the fusion of the glass and with
parallel platinum leading-in wires passing through the
glass on one side of the chamber, and with definite
means for attaching a carbon filament to the wires—if
all these matters had been explained to you speci-
fically so that the procedure was definitely fixed, and
as to the carbon filament you were told to use for this
purpose a properly carbonized cotton thread, what
shape would you have put the thread into?

A. If the length of the thread were such as to be 6498
connected from one wire to the other simply, probably
it would have been put in as a straight strip. If it
were longer than this, either the wires would be extend-
ed or the strip might be bent. If still longer it is quite
likely that it might be given a turn in the bulb. I do
not know whether the expedient of coiling would have
been likely to have been adopted or not. Certainly,
the expedient of very closely coiling, so as to restrict
the radiating surface, seems to me to be a matter a lit- 6499
tle outside of what might be assumed to be done.

181 x-Q. The putting of the cotton thread into these
plain forms, that is, straight or bent into more or less
of a loop or arch, would have been suggested by the
exercise of good skill and judgment had the instruc-
tions given you as assumed in the last question been
indefinite in this respect?

A. Yes, it is true that the form of a strip or bent
piece was known in the art, and it would be natural to
put the thread in that form.

182 x-Q. In criticizing the patent and assuming a 6500
lamp with a closely-coiled spiral burner, as you have
done in your answers 6 and 8, you have omitted to
consider what would be done as a matter of good skill
and judgment, provided the constructor found a spiral
unsuited to his purpose or unnecessary by reason of
his having a steady current to work with, have you
not?

6501 A. No, I think I simply took the specification as describing and laying stress upon that structure which embodied the invention. In other words, I took the specification as a disclosure of what the invention consisted in, in accordance with its statements, assuming that the inventor was describing the invention in its best form and specifying distinctly in what respects the invention of the patent differed from other inventions. I do not think, in answering the questions, I was called upon to go outside of the questions and assume
6502 things which were not distinctly set forth in the specification.

183 x-Q. As a matter of fact, however, you did omit to consider the case of the use of an uncoiled or plain filament, and that form you now admit was the form which the state of the art and good skill and judgment would have suggested for use, provided the constructor had found the closely-coiled form not suited to his purpose, or unnecessary by reason of having a steady current to work with?

6503 A. I answered the questions as put, which related to the construction described in the specification and shown in the drawings. So far as my criticisms go on the coiling as an element of imperfection in the lamp, I think I have pointed out that the procedure of coiling produces great disadvantages. I have made other criticisms which are aside from the mere fact of coiling, though undoubtedly the chief defect and the greater part of the disadvantages arise from the coiling of the burner. The disadvantages of carbonizing
6504 after setting the conditions of the lamp, of course remain, whether the coiling is done or not. The disadvantages of manipulation of the tar-putty thread are lessened by dispensing with the coiling. The disadvantage of forming the union of the platinum wires with the plastic thread before carbonization is still present, though perhaps not in the same degree as when the coiling is done. The fact that the specifica-

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tion is not at all definite as to any structure being used or contemplated other than a coiled structure, I suppose, accounts for questions 6 and 8 and my answers thereto.

Adjourned at 1 P. M. for lunch.

Hearing resumed at 2 P. M.

184 x-Q. You have stated as one of your criticisms of the structure described in the patent in suit that 6506 the conditions are set before carbonization. Please explain more fully what you mean by this?

A. I meant by this that before the carbonizing process, the burner was practically constructed and could not be changed should it be found after carbonizing to require adjustment, the carbonizing process giving a variable result would lead to variable conditions of the burner which might be in a measure compensated for if the carbonizing was done first and the mounting afterwards. 6507

185 x-Q. How is this difficulty obviated in practice at the present time—briefly?

A. In many cases the carbon after being carbonized has its resistance measured, and if it falls below or comes above a certain standard it may be rejected. If however, it is desired to reduce the carbons to a definite standard, operations such as are known under the name of "treatment" can be applied for reducing the resistance of the carbon to a determinate amount, so as to produce it as near as possible of a standard conduc- 6508 tivity or resistance.

186 x-Q. The treatment you refer to now, I take it, is what is known as the hydro-carbon treatment consisting in immersing the filament in oil and heating it by an electric current while so immersed, and thereby depositing additional carbon upon it, and thus reducing its resistance to any desired extent. Am I right?

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A. Yes, that is what I mean except that I do not restrict the statement to immersion in oil, but any hydro-carbon material, such as oil or vapor. I would say also, in supplementing my answer preceding, that the variations of shrinkage during carbonization will necessitate compensation if the lengths of incandescent material in use are to be adjusted.

187 x-Q. How is this second difficulty overcome in practice at the present time?

A. It is overcome by measurement of determinate
6510 lengths after carbonization.

188 x-Q. And the cutting off the ends of the carbon, if necessary?

A. Yes, that is the usual procedure, or if the ends are not cut off, the adjustment may be made in the joining process to the platinum, the carbon being mounted so as to project more or less.

189 x-Q. Now, with respect to the adjustment which may be accomplished by the hydro-carbon treatment,
6511 that was known before the date of the application for this patent, was it not?

A. Broadly speaking, I think it was. It was known that variations of resistance could be obtained by heating carbon incandescent conductors in hydrocarbons, such as gas, vapor or oil, either doing this by the current, or by simply heating; the current being by all means the best for use.

190 x-Q Or it might have been done by dipping the carbon in carbonizable solution and then recarboniz-
6512 ing, might it not?

A. Imperfectly I suppose it might be so done, although all these operations, of course, reduce the resistance of the carbon and change its nature, tending to make it of comparatively low resistance.

191 x-Q. Still, they are processes which were known

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prior to the patent in suit, and which are capable of being carried to any desired extent so as to produce the small variations in resistance necessary for adjusting the resistance of the carbon filament?

A. That is not exactly as I should put it. While the processes might be known as means for reducing the resistance of carbon and carbon bodies generally, yet when the object is to attain high specific resistance, it seems to me that these processes were not known in the degree of refinement required in such a case.
The lamp of the patent in suit is supposed to be 6514
made of high-resistance carbon, and the higher the better. I do not know that it was known that these processes, such as soaking in carbonizable materials and afterward re-baking, could be counted on to give any definite resistance; one difficulty being that the temperature of carbonization has a good deal to do with the operation, as also does the effectual exclusion of gases which might corrode or combine with the carbon.

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192 x-Q. The process of heating by the current while the carbon is immersed in a hydrocarbon vapor or liquid, however, is one which was known before the date of the patent, and was capable of the fine adjustment you have referred to, was it not?

A. I suppose it was capable of it.

193 x-Q. Then if a constructor making the carbon described in the patent in suit had found the filaments
to vary materially in resistance, a process was 6516
open to him which, by the use of good skill and judgment would have enabled him to adjust the resistance to the same standard?

A. I hardly think so. He would, in attempting to do this at the date of the patent, have found it necessary to adopt precautions not then known, and which involved a considerable degree of experiment and in-

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vention, that is, assuming that he desired to preserve the character of specifically-high resistance in the burner.

194 x-Q. Why do you make this last qualification? Assuming that the constructor was primarily desirous of bringing the carbon filament to a standard resistance, would he not have been able to do so by the exercise of good skill and judgment by using the known
6518 process?

A. I think he would have found considerable difficulty in it, and, as I said before, the operation might require an amount of care to secure the result not then known in the art, if it did not require invention. I speak of high resistance in this connection inasmuch as the lamp is supposed to preserve a high resistance specifically, that is, the filament is to be of such a texture of carbon as to resist the passage of the current more than ordinary forms of carbon would do, and I
6519 take it that at the date of the patent in suit, the constructor would have found it very difficult indeed to bring the resistances to anything like uniformity without taking away that; and I think further, that even removing that feature, the difficulties would have been quite great, the operations of securing a fair uniformity such as would be evident when the lamp was put to use being even different from that of securing uniformity before the lamp is put to use. It is not a mere case of deposition of carbon but a case of deposition in a spe-
6520 cial way.

195 x-Q. Still, if the necessity was paramount of adjusting the carbons to an equal resistance, the process was known by which that could be done with the skill which would have resulted from continued attempts to use the process for that purpose?

A. No, I do not think that would be a proper statement of the case. The methods and precautions to be

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used in the treatment were really an after-growth, and while the broad idea of affecting the density and resistance of the carbon by the passage of the current while surrounded by hydro-carbon, was undoubtedly known to the art; yet to do it effectively and for the purpose in question, that is, securing uniformity, it seems to me was a subsequent development in the art and a gradual one at that. The operation would have been much more easy to perform of course in any case if the resistances desired were comparatively very low; but 6522
for the nice adjustment of such high resistances as are here in question, or for modifying the specific resistance of carbon of high resistance as is here involved, would, I think, have been a matter unknown at the time or a thing which required subsequent study and experiment to develop.

196 x-Q. You do not believe then that the Sawyer-Man patent, No. 211,262 granted January 7, 1879, is sufficiently complete to enable this process to be carried 6523
out without experiment amounting to invention?

A. The Sawyer-Man patent I think does describe a process for producing a dense, homogeneous carbon from a less dense and homogeneous carbon; and this it does by immersing the carbon in a hydro carbon gas or liquid while it is heated by an electric current. I do not think that the patent goes so far as to state the requirements which would make this process suitable for the purpose of adjusting resistance of carbon burners similar to that of the patent in suit, though I do say 6524
that it is sufficient as describing the operation of solidifying carbon or increasing its conductivity by the treatment in hydro-carbon. The difference is one of performing the operation in a special manner as against performing it at all; and it is the special manner of its performance which I think was missing at the time of the issue of the patent in suit, and this manner was developed afterwards.

6525 197 x-Q This difficulty, arising from the lack of
equality which you think would appear in the carbon
filaments made in accordance with the patent in suit,
could be obviated by the testing of the carbons and a
proper sorting of them into groups having approxi-
mately the same conditions, together with the discard-
ing of such carbons as had extreme conditions of re-
sistance, could it not ?

A. I think this could be done provided the testing
referred to is that of the finished lamp, that is, the
6526 lamps instead of being produced in any way uniform
would turn out to be of all scales of resistance and
illuminating power under the same conditions, and it is
of course quite possible that they could be classed into
a number of classes varying in these respects, but this
would have to be done in my opinion, after the whole
structure was completed and finished. Moreover this
statement simply brings out more clearly the criticism
which I have made, namely, that the process laid down
for the construction of the lamp of the patent in suit
6527 is not capable of giving, along with its other defects,
anything like uniformity.

198 x-Q. Care and increased skill in manipulation
arising from experience in carbonizing, would tend to
make the carbons more equal in resistance, would it
not ?

A. It might; but it would not remove the objections
of having the conditions set before they should be in
the process, or in other words, it would not remove the
objection to the lamp which is an objection not pre-
6528 sent even in the older forms of incandescent lamps,
where the carbon selected beforehand is mounted,
this being in fact the method of procedure adopted at
the present day in making incandescent lamps. In so
far as the patent departs from the older method in this
respect it is in my opinion misleading and defective,
and gives warrant for my statement that I did not be-

lieve that serviceable lamps could be made in that 6529
way, and further accounts for the fact that they have
not been, so far as I know, at any time in the progress
of the art.

199 x-Q. Do you refer now to the inability to cut
off the ends of the carbon resulting from mounting it,
as you term it, before carbonization ?

A. I refer to the whole operation of preparing the
burner with the wires and carbonizing it.

200 x-Q. You have stated that two methods of ad- 6530
justment were in practice at the present time, as I
understand you: one, the hydro-carbon treatment, the
other the measurement of the length of the carbon and
the cutting of it off at its ends or equivalent means to
bring it to a definite length. Now as to the first of
these processes of adjustment; it is a fact, is it not,
that even at the present day all manufacturers of in-
candescent lamps do not use this process ?

A. I am not fully informed on that point. I can say
that if they do not, they undoubtedly carbonize before 6531
mounting on the wires, and carbonize under such con-
ditions and by such exact methods as were not known
at the time of the patent in suit.

201 x-Q. Do you not understand that the complainant
in the manufacture of its lamps does not use this
hydro-carbon process that you have stated is one of
the methods of adjustment, and that its lamps are
tested and assorted into groups so as to overcome the
difficulty of inequality due to carbonization ?

A. As a matter of hearsay, without having examined 6532
into the question, or without having the opportunity
of examining into this question, I would say that I
have understood that no treatment in hydro-carbon is
used by the complainant; but I have understood on
the other hand that very careful manipulation and
that very special carbonizing processes have been de-
vised or invented for securing uniform carbonization

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I know that a number of patents have been taken out by Mr. Edison on the carbonization process, surrounding it by all kinds of refinements, with the purpose no doubt of avoiding as far as possible the irregularity or lack of uniformity. I understand also in accordance with the question that, despite these facts, these improved carbonization methods have not so far succeeded as to render it unnecessary to sort the lamps into groups or batches.

6534 202 x-Q. Do you know of any manufacturer of incandescent lamps that does not find it necessary to sort and test the lamps, notwithstanding the employment of the hydro-carbon treatment process?

A. There are of course always a certain number of imperfect lamps, but the treatment process with its refinements I know to be capable of securing results very much closer to standard—in fact, practically so close as to produce lamps of standard character.

203 x-Q. In the manufacture carried on by your
6535 company you use the hydro-carbon treatment, do you not, to produce this fine adjustment?

A. Yes, not only to adjust but to form or produce the carbon conductor by deposition of carbon.

204 x-Q. What variations in voltage do you find it necessary to produce as a commercial measure; take for instance, your 16 candle lamps intended for pressures in the neighborhood of 100 volts?

A. I have not noted the exact percentage. I would say that the variations are greater in lamps of this
6536 character than in those which undergo a larger proportion of treatment. There are, outside of a set of lamps which are rejected as defective from one cause or another, variations of a few per cent, I believe.

205 x-Q. The variations, however, are sufficiently great so that you find it desirable to sort the lamps into groups and arrange your plants to use different pressures of current, so that the groups for one pressure are used on one plant and those for another pressure on another plant?

A. I have not looked into this matter and cannot say 6537
whether it is so or not. It may be so, but my time has been so taken up with matters outside of the details of lamp manufacture, especially recently, that I do not know what the present practice is in that respect.

206 x-Q. The lamp manufacture of your company then is not directly under your charge?

A. Not so far as the details of the business go, or the commercial end of it; in fact my time has been very fully occupied of late years in taking care of many
other matters, such as designing new forms of appli- 6538
ances, machinery, etc., for electrical railway work; also in giving testimony in numerous cases of one kind and another—interferences in the Patent Office particularly—that my opportunities for following the factory developments are comparatively meagre. I remember, however, discussing some time ago—I think about six months ago—this question of variation on incandescent lamps, particularly the 110-voltage class, with the foreman of the lamp-making, at which time the question
of dividing into groups was spoken of. He had noted 6539
a variation of a few per cent. in the out-put, particularly on these lamps. I advised him at the time to refine his methods and get rid of the variations if possible, as I thought it was a great disadvantage to group the lamps according to their variations. What the outcome of this was later I have not inquired, as the matter has not been called to my attention.

207 x-Q. You knew then what the voltages were that you were making at that time, although you do not
at present. I refer of course to 16-candle lamps 6540
having a voltage in the neighborhood of 100 volts?

A. My recollection is that the statement was made to me that they varied a few per cent., and the foreman asked simply whether he should divide them into groups, and that I advised refining the processes so as to avoid if possible such division. I think that he stated at the time that a division into two sets or three

6541 sets at the most would be all that was necessary or useful, though the matter has in a considerable measure passed from my mind.

208 x-Q. Would you be surprised to learn that these lamps varied between extremes as wide as 95 and 110 volts, and that variation still exists in the factory of your company?

A. I might be a little surprised that the variation was as wide as that.

6542 209 x-Q. How wide a variation would not surprise you as existing at the present time in the factory of your company?

A. Well, in the first place, I would not be surprised to find a variation or 25 per cent. in extremes, but the proportion which would so vary, I would be surprised if there were more than a small fraction due to accidental happenings during the process, as by the entrance of air into the pumps during exhaustion. I should be surprised, however, if they vary more than
6543 from 5 to 10 per cent, that is, taking the batch of lamps which had gone through the operation without difficulty. I would say that the variation when it occurs is, as I understand it, produced during the final exhaustion of the lamp.

210 x-Q. Variations between carbons in different batches, as well as those between carbons in the same batch, have to be provided for by testing and sorting, do they not?

A. It is here that the treatment process is of great
6544 avail. A batch of carbons carbonized at one time would naturally vary somewhat from a batch of carbons carbonized at another time at a different heat; but the treatment process comes in here to bring things to comparative uniformity. It must not be forgotten that the treatment process itself is a carbonization process as well as a treatment. During the treatment the carbon is heated by the current to an exceedingly

high temperature in order that the carbon deposited 6545
may not be combined with hydrogen but shall be pure carbon. Much in fact depends as to uniformity on just this part of the operation, the temperature of treatment being an important factor; for this high temperature not only completes the carbonization by relieving the carbon of hydrogen, but deposits pure carbon. I have never known of any sorting of one batch as distinguished from another batch being carried out, though I can readily understand that where a carbonization process 6546
alone is relied upon without treatment, such a sorting operation would be essential.

211 x-Q. Do you know what variation in voltages of lamps of the kind we have been speaking of, the books of your company will show you find it necessary to keep in stock in order to accomodate this sorting process, notwithstanding the fact that you use the hydrocarbon treatment?

A. No, I have not examined into the matter recently. 6547

212 x-Q. How wide a variation in voltage of lamps of this character—that is 16 candle lamps using in the neighborhood of 100 volts—would you use as a practical measure upon the same circuit?

A. That depends upon the conditions of the circuit and in a measure on the illuminating power of the lamp.

213 x-Q. Please answer the last question under the 6548
ordinary conditions of practical use which you have observed in the business of your company?

A. I believe that a variation of about from 3 to 5 per cent. is admissible, though of course it would be better if they did not vary at all.

214 x-Q. A variation of 10 per cent. in the voltage then would require a division of the lamps into at

6549 least two groups and the providing of circuits having at least two different standard pressures?

A. I think it would be advisable in such case, although as I said before, the conditions of the circuit may have something to do with it.

215 x-Q. Do you not think a variation of 10 volts would make a sorting into more than two groups advisable?

A. It might if the proportion of lamps departing
6550 from the middle range was very large.

216 x-Q. Then it comes down to this with regard to this question of the adjustment of the carbons; that with the employment of the hydro-carbon treatment, some degree of sorting is still advisable, or, as a matter of fact, is employed as a commercial measure in manufacturing. Without the hydro-carbon treatment, sorting of the carbons is necessary probably to a larger degree notwithstanding the refinements introduced into the
6551 process of carbonization; and without those refinements and without the hydro-carbon treatment, sorting to a larger degree would be necessary?

A. Yes, stated broadly, that would be probably correct, though I think that in the case of carbonizing without the refined methods and particularly after the conditions of the lamp-structure are set, would give rise to such irregularities as would make it almost prohibitory to construct lamps; the range would be too great. The hydro-carbon treatment, I think, if carefully
6552 carried out, is capable of producing very close results as to uniformity.

217 x-Q. This greater range of variability would mean the necessity of establishing a greater range in the pressures of the currents employed, would it not?

A. Undoubtedly it would—a very much greater range.

218 x-Q. With regard to the second element of adjustment, namely, the ability to cut off the ends of the 6553
carbons, all carbons made with enlarged ends have fixed conditions in this respect, have they not?

A. Yes, they should have. I do not mean it to be understood that this adjustment is to be regarded as a substitute for the treatment process. It might go a small distance in becoming a substitute.

219 x-Q. I call your attention to the defendant's 6554
zigzag lamp, the defendant's tamadine lamp and the defendant's M lamp (the three lamps upon which this suit is based) as illustrated by the drawings forming a part of complainant's *prima facie* record; do not these lamps have carbons of fixed conditions arising from the employment of enlarged ends?

A. As far as the length of the carbon goes, yes.

220 x Q. Is it not a fact that until within two years all, or the larger part, of the incandescent lamps practi- 6555
cally made and sold had carbons with enlarged ends not adapted to be cut off to vary the length of the incandescent portion of the carbon?

A. In the lamps which I had to do with, there have not been at any time enlarged ends used, so that an adjustment of length has been practiced since 1884 or 5. I may say that, as far as I know, many of the lamps made abroad in England have been made without the enlarged ends from quite an early period.

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221 x-Q. With respect to your criticism of the practicability of the processes described in the patent in suit, have you ever attempted to make a lamp by those processes?

A. No, I have not.

222 x-Q. Your opinions are based then entirely upon theoretical considerations?

6557 A. No, I think not; based somewhat on practical mechanical experience.

223 x-Q. Did you ever try to make the filament composed of tar and lamp black described in the patent in suit?

A. No, I have tried a composition in which fine graphite was mixed up with a syrup and forced out of a small opening, and I found the process was indeed a
6558 very difficult one. I think it quite likely that by a very thorough incorporation and grinding the *filière* method of forcing the paste through an opening might give a fine thread. The rolling process I should think would be very difficult indeed to manipulate and almost impossible when the coiling was taken into consideration. This I have before stated to be my judgment of the matter.

224 x-Q. You have not tried it, however, so as to
6559 reinforce your judgment by actual experience?

A. No, I have not tried it.

225 x-Q. Do you know how high a heat would be required to carbonize such a tar-putty filament as is described in the patent in suit?

A. It will carbonize, as the ordinary expression is, at about 1,000 degrees Fahrenheit, or a red heat or even less than that; but the carbonization or carbonizing so obtained is not a complete one by any means. There is required as high as possible a temperature to complete the carbonization. It is well known that it is
6560 only by an exceedingly high temperature that carbon free from combination with hydrogen can be produced, and if it is not produced in the carbonizing process the passage of the current will cause further carbonization, and introduce variations in the nature consequent thereon. In fact the melting point of platinum is not much out of the way from complete carbonization. The melting point of iron may be taken perhaps as sufficient for most purposes.

226 x-Q. Are you aware of the fact that at the date 6561
of the patent in suit carbonization was done in iron boxes most usually, and is so described in the literature upon the subject?

A. Certain kinds of carbonization were; other kinds were done in black lead crucibles at the highest attainable furnace temperature.

227 x-Q. The various difficulties set out in your answer to question 8 as to forming a fine, uniform thread of the tar-putty described, its coiling, its carboniza- 6562
tion in the manner described with the platinum wires secured before carbonization, are matters of opinion expressed without your actually having tried the particular thing; am I right?

A. I think they are self-evident difficulties besides being matters of opinion.

228 x-Q. Now, with reference to the opinion you have expressed about carbonizing with the use of a helix of copper wire, where do you find in the patent authority for the statement contained in your answer to 6563
question 8 that the thread is to be wound *upon* a spiral of copper?

A. In answering the question I was quite aware that the specification says that "it is to be coiled between a helix of copper wire." I interpreted the language literally, as by so doing I was able to see that the coiling was possible, understanding that "between" means, in my judgment, in the little, narrow space between the turns of a copper coil. How it could be
coiled between the turns of the copper without this 6564
idea being involved, I do not see. The operation becomes still more difficult unless there is introduced additional apparatus such as a mandrel for receiving both the copper and the carbon tar-putty. Besides, if it is to stay in place at all, the helix of copper must, it appears to me, be a support for the carbon. If it were coiled between the coils of a copper spiral by using a

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mandrel so that it was equally free to move in or out in my opinion it would be almost impossible to keep it in place unless it stuck to the copper, which is of course, an objection anyhow. It would be kept in place if wound on a spiral between the wires; and this operation, even if the copper spiral were slightly open, possibly might be performed without rupture of the thread, though I think it would be in any case, even with this condition, a difficult operation.

229 x-Q. You never tried this particular thing your-
6566 self?

A. No, I have not tried it.

230 x-Q. Did you ever make a spiral carbon burner?

A. No.

231 x-Q. Is it not a fact that the ordinary way to wind a spiral of any material is to wind it upon a mandrel?

A. Yes, a helix is so wound, and I suppose the word spiral in this connection is to be taken as meaning a helix; but the spiral is generally taken off the man-
6567 drel if it is to be used for any purpose.

232 x-Q. If you had been handed at the date of the patent in suit a thread of plastial material and told to wind it into a spiral, would you have attempted to turn it in the air, or would you have used a mandrel to wind it on?

A. That would depend on its nature. If it were sticky and gummy I might attempt to do it in the air.

233 x-Q. I mean what would have been the usual mechanical way of doing it, assuming of course that it
6568 was not so sticky as to stick to a mandrel while winding?

A. Then of course if the properties of the material are such that it can be wound most readily on a mandrel, a mandrel would be used undoubtedly.

234 x-Q. You would not have to be told to use a mandrel in order to have that suggestion occur to you as a mechanic?

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A. No, certainly not.

235 x-Q. Now if you wanted to wind such a thread in the form of a spiral with an accurate spacing of the turns, would it not have been a natural thing, suggested by ordinary skill to provide a mandrel having grooves into which you could wind, or, better still, in order to provide for the slipping off of the mandrel, to slip a helix upon the mandrel which would act as a substitute for the grooves, and wind between the turns of the helix?

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A. I think these procedures mentioned are reasonable, apt to be adopted, and I take the former one of them as being fulfilled by the copper wire; that is, the copper wire was to form, as I read the specification, the mandrel. Between its turns the carbon thread was to be wound while still plastic. The thread and its support would then be put into the carbonizing box or chamber. The copper afterwards was to be dissolved off by acid if it did not melt away. Nothing being said in the specification about the mandrel, I took the 6571
first, most natural, idea in connection with the matter: in fact I am at a loss to see that it means anything else than what I have said.

236 x-Q. I would quite agree with you on this point if the patent said to wind *upon* the copper helix, but in view of the fact that it specifies winding *between* the turns of the copper helix, would not good skill and judgment have, at the date of the patent, supplied the mandrel if the workman had found in trying to carbonize by winding the thread directly upon the copper 6572
helix, that it was broken in carbonization?

A. I understood the copper to be a support for the helix during carbonization. In this case I should say that in my opinion the word "between" must refer to the carbon being coiled between the adjacent turns of the helix and in a manner to be supported thereby. This would give the arrangement which I suggested.

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If the mandrel is to be assumed to be present and the
carbon not to receive its support from the copper, I
think the arrangement would be to coil it between the
turns of the copper as suggested and on the mandrel;
but unless the thread sticks to the copper when the
mandrel is removed, there would be again a difficulty
introduced.

237 x-Q. Why should you remove the mandrel before
the carbonization is completed?

A. Simply because if it is a metal mandrel the car-
6574 bon will shrink just as it would on the copper; in
other words, if we are going to improve the process let
us improve it so that it will work. If we are going to
assume the mandrel present during the operation, we
will have to assume that it shrinks about as the car-
bon does or more. If it be metal, the carbon will
shrink around it, and, in my opinion, break.

238 x-Q. How do you know that the shrinkage of
such a thread upon a mandrel, even though the man-
drel is of metal, will not be taken up by the drawing
6575 up of the ends of the thread and by the flattening of
the thread against the mandrel?

A. Simply because, being a tar-putty composition,
it will soften before it carbonizes. As it begins to
carbonize, it will begin to shrink. It will stick more
or less to the mandrel, and its length is such that the
slipping process is hardly to be considered as consistent
with the small diameter of the carbon itself. I would
here emphasize the fact that the first carbonization, or
setting in the solid mass, is merely the driving out of
6576 the volatile matter, after which a considerble shrink-
age will take place.

239 x-Q. Before leaving the mandrel, however, and
without committing yourself as to whether the process
would be an operative one even if the mandrel were
used, do you agree with me that a mandrel upon which
both the copper helix and the carbon thread formed

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upon the mandrel between the turns of the helix would
be placed, could be supplied by the mechanic and with-
out the exercise of invention?

A. It is very difficult to answer that question, as it
imports into the consideration of the subject certain
things which are not hinted at and which in my judg-
ment leave out of consideration what appears to me to
be stated to be the thing used for the support of the
carbon thread, namely, the copper helix itself.
Whether modifications would be made by the workman
operating the process, which would involve the use of 6578
the mandrel and the copper wound there, I am not pre-
pared to say; possibly such modification might be
made. I take it that the copper having to be dissolved
away afterwards by nitric acid is an indication that
the carbon thread is very closely related to the copper,
or supposed to be, after the carbonization. Otherwise
I think that if there had been a mandrel present it
would not have been very difficult to have removed the
copper, provided it does not adhere to the carbon thread,
by ordinary mechanical means. 6579

240 x-Q. I call your attention to the paragraph in
the patent which says "With substances which are
not greatly distorted in carbonizing, they may be coat-
ed with a non-conducting, non-carbonizable substance,
which allows one coil or turn of the carbon to rest upon
and be supported by the other." I. following this
direction assuming the proper materials were supplied
to you, would you use a mendrel to wind upon?

A. The specification says nothing about it. It is
difficult to say what should be used in such a case. I 6580
have no doubt that in any process of coiling a mandrel
would be an assistance.

241 x-Q. And would be supplied by ordinary me-
chanical skill?

A. Possibly.

6581 242 x-Q. It is an older device for such purpose than the earliest recollection of any of us present?

A. Oh undoubtedly the winding of a helix has been generally accomplished by using some support such as a mandrel or its equivalent.

243 x-Q. Now in this instance of the use of the non-carbonizable coating, the coils are intended to be supported laterally one upon the other, are they not?

A Yes, I believe they are; the coating being re-
6582 garded as a septum or separating substance.

244 x-Q. Taking this statement and the previous statement with regard to the helix of copper wire together, is it not a reasonable construction of the language that the copper wire was to be used as a separating device for the coils—it was not to take the place of the ordinary supporting mandrel?

A. Possibly, were it not stated on the first page of
the patent, line 93, "and the same may be coated
with a non-conducting non-carbonizing substance and
6583 wound on a bobbin, or as a spiral." There seems to
be a distinction drawn between winding it on a bobbin
and winding it as a spiral, the bobbin, which may be
taken as a mandrel, being used when the carbon thread
is connected with non-conducting, non-carbonizing
material and the simple, plain-spiral form to be given
when this is not done; or perhaps it means that even
when it is so coated, it is to be either wound on a
bobbin or as a spiral; that is, on a mandrel or off a
mandrel.

6584 245 x-Q. Is it not a fact that the language used just referred to is entirely consistent with the idea that the spiral is stated as the result of the winding on the bobbin; that is, alternate forms of expression for describing the same thing which could be better described by simply omitting the word "or."

A. Yes, that is one possible interpretation.

246 x-Q. Now take this statement in the patent which, thanks to you, has just been noticed in this

connection, which supplies the mandrel, and consider 6585
it with the statement with regard to providing a helix of copper wire between which the thread is wound, if it is liable to be distorted during carbonization; is it not a fair interpretation of the intent of the patentee, as shown by the specification, to use the copper helix as a spacing device and not as a substitute for the mandrel?

A. Really I cannot say. I don't know whether it is
intended that the bobbin referred to shall remain or 6586
be removed. In Mr. Edison's former patent with the
platinum lamp, the platinum wire is wound and supported by a bobbin, and it is possible that another interpretation may be found for this statement, that is that when the tar-putty composition is connected with a non-conducting, non-carbonizing substance it can be wound on a bobbin just as with the platinum wire. I am unable to say that it involves the idea of a mandrel, taking this view of it, though I am not prepared to deny
it either; it simply is indefinite. 6587

247 x-Q. With regard to the tar composition is it not a fact that the extent of shrinkage in carbonization and also the tendency of the thread to stick to a mandrel upon which it is wound, would depend upon the percentage of tar in the composition?

A. It would in a measure depend upon this percentage. The dryer the composition was, of course the less sticky it would be.

248 x-Q. You have no idea yourself of how high a
per cent. of lamp black can be worked into a composi- 6588
tion of lamp black and tar by the kneading and rolling process, have you?

A. I should suppose that a very good percentage could be, reasoning from analogy with other pastes of a similar kind Whether the desired degree of plasticity would be secured with any particular percentage, I am unprepared to say. The indication is that it is to be like thick putty.

6589 249 x-Q. These minute questions of what would be the results in detail of attempting to make a tar-putty filament such as described and to carbonize it the ways described, or such modifications of them as would be supplied by skill and judgment, are all things which can far better be determined by actual experiment than by *a priori* reasoning?

A. I do not consider that they are for *a priori* reasoning at all. I do think, however, that when a statement is make as to procedure, it would be rather full
6590 and exact, so that it can be practiced without an amount of experimenting which would be carried on at length and be attended with failure before the right thing was hit upon.

250 x-Q. Have you ever tried to attach metallic tips of platinum to a carbon filament before carbonization?

A. No.

251 x-Q. Assuming that you could maintain the relation between the carbon filament and the wire tips
6591 during carbonization, these wire tips would form good surfaces to clamp to, would they not?

A. Yes, undoubtedly. They are evidently used for that purpose in the lamp, as shown in the drawing.

252 x-Q. Is it not a fact that at earlier stages in the art it has been found desirable in the use of mechanical clamps to provide the carbon burner with metallic tips for securing good contact in clamping?

A. Yes, that operation has been practiced on other carbon bodies than carbon burners, as for example
6592 battery plates.

253 x Q. In the second of the two lamp patents of yours which have been put in evidence, you will recollect that the ends of the carbon filament are plated with metal in order to give good contact to the clamps?

A. Yes, in order to enable them to be clamped by the wires, or to be brased or soldered, as might be.

254 x-Q. Then the objection in your mind to the use of the platinum tips on the carbon burner of the patent in suit is what you take to be the difficulty of producing a burner with such tips attached, rather than the lack of utility in the construction, if it were possible to produce it practically. 6593

A. The difficulty I referred to was that the specification did not point out how the platinum wires were to be supported during carbonization, and that the carbon burner itself was to be formed before carboni- 6594
zation with the wires attached, which procedure I do not regard as the proper procedure, and I had no criticism on the wires themselves in place. If they had been attached after carbonization when the conditions of the burner were still capable of variation there would certainly be an advantage in mounting.

255 x-Q. Would not a careful packing of the carbon filament with the attached wires in powdered carbon before carbonization form a support to maintain the relative position of the parts? 6595

A. I should fear that in this case the composition tar-putty in shrinkage would be apt to pull away from the wires, especially as the enlarged portion would be imbedded in the powdered carbon and have to be drawn or pulled a little through it. This however was from the fact that no statement of the packing is given in the specification, and I do not doubt that with special arrangements for providing for the shrinkage and great care throughout the process, it might be possible that some of the burners would come out in- 6596
tact.

256 x-Q. The enlarged carbon ends in drawing up would make holes big enough to draw the wires after them, would they not, if there was any adhesion between the wires and the carbon ends?

A. I do not think that need be taken into consideration. The wires I think would draw all right, only they

6597 are rather heavy and only held to the main body of the spiral by an extremely small diameter of thread. The joints themselves I think would be the main obstacles as far as resisting shrinkage is concerned.

257 x-Q. The process of packing in powdered carbon for carbonization was one long known prior to the patent in suit?

A. Yes, without question. Articles were packed for carbonization in carbon dust or powder.

6598 258 x-Q. You understand that these wires which were attached to the carbon burner before carbonization are not intended to be sealed into the glass by the patent, but are to be clamped by mechanical clamps or otherwise to the wires which are sealed into the glass, do you not?

A. Perfectly. I have understood that all along. Of course I have been perfectly aware that the glass would melt and get out of shape during carbonization, and it would not be advisible to mount the thing on

6599 the glass and attempt to carbonize it in a carbonizing vessel. The little clamps shown in Figs. 1 and 3 and designated *h h*, are manifestly intended to make the union to the wires in the glass after the burner itself had been finished.

Adjourned at 4.45 P. M. to Wednesday February 19, 1890.

BOSTON, MASS., Feburary 19.

Met pursuant to adjournment.

6600 Counsel present as before.

259 x-Q. You have stated in substance that one of the difficulties with the coiled form of carbon burner is that there will be an unequal heating of the burner, the center being much hotter than the ends, and that this would, as I understand you, materially shorten the life of the burner in operation. Would not tha danger be obviated to a practical extent by running

the lamp so that the portion of the burner having the greatest heat would be at a durable temperature rather than at an excessively high one? 66 1

A. If I understand the question it assumes that the middle portion of the spiral be heated by the current, or the current regulated to heat the middle portion of the spiral, only to that point giving the middle portion a considerable durability. Under these conditions assumed, undoubtedly the destruction of that middle portion would be prevented; but at the same time 6602 the other portions outside thereof would be at so low an incandescence as to be very inefficient and wasteful of the heating energy of the current, and the light would be of a ruddy tint. The great objection, however, to the spiral is, that on account of the fact that the lamps would not be uniform, this nice adjustment of the incandescence of the middle of the spiral would be practically one which could not be insured unless a single lamp alone were used on a circuit by itself and the current adjusted on that circuit.

6603

260 x-Q. You are now assuming, are you not, that the lamps are not carefully tested and assorted into groups or batches having approximately the same conditions?

A. I, of course, am assuming that the lamps are made in accordance with the specification and used as so made. They might be sorted into batches, but I think the number of batches would be very great, if the condition just set down, that is, of a restricted incan- 6604 descence of the middle of the spiral, be attempted to be attained.

261 x-Q. Would it surprise you to learn that closely-wound spirals such as those described and shown in the patent in suit, show no noticeable difference in temperature between the centre and the end portions?

A. I should certainly not expect any such result with

6605
a spiral wound so closely as to restrict the radiation of light from the spiral. I, of course, would expect that if the spiral be not so closely wound that there is no decided restriction in this respect, the effects might not be marked.

262 x-Q. The precise fact, however, is one which for purposes of certainty, is much better ascertained by actual experiment than by theoretical reasoning, is it not?

6606 A. The fact is one which to my mind must exist outside of any other considerations. The spiral when wound may fail to give such restricted radiating surface, and I may say here that to secure this restriction requires very close winding in my opinion, and so the effect might not be very noticeable in the cases where no particular restrictions of effective radiating surface as compared with the total radiating surface, had been made.

6607 263 x-Q. Any degree of coiling however, affects a corresponding restriction of the radiating surface, and the closer the coiling the greater the restriction, is not that so?

A. Yes, only that to get any practical restriction requires pretty close coiling.

264 x Q. Such a closeness of coiling as is shown in the drawing of the patent in suit you would not expect to show any considerable variation in the temperature
6608 between the centre and ends of the coiled burner, would you?

A. No, no considerable restriction of radiating surface. I hardly think the drawings can be taken as working drawings in this respect. Rather we must understand what they mean by the specification. Taking the relations indicated in the specification, I should say that the intention evidently was to wind a consid-

6609
erable length of conductor into a spiral and such a length as would not be heated by the current passing through it, if spread out, to any considerable incandescence, the incandescence being attained by the fact that the spiral is a rather close spiral. The references to the length of pieces of the tar-putty composition and the resistance attained by it in the coiled form, indicate quite a number of turns in the spiral. In the specification, in the paragraph beginning line 60, it is said that "small pieces of this material may be rolled
out in the form of wire as small as seven-one-thou- 6610
sandths of an inch in diameter and over a foot in length, and the same may be coated with a non-conducting non-carbonizing substance and wound on a bobbin or as a spiral." This indicates to my mind that about a foot of the material was to be wound into the spiral, and I do not think that a foot of it could be made to give as few turns as shown in the drawings, nor could a foot of the material in my opinion be wound in the relative space shown without involving a
very large number of turns. The fact that the carbon- 6611
ized thread spoken of is to be wound into a spiral and of 2,000 ohms resistance simply points out the same fact, that the spiral was to have many turns closely wound. The fact that when wound reference is made to coating with a non-conducting material to keep the spirals apart indicates very close relation of the turns of the spiral. All these things taken together can but have one meaning, and that is, the spiral was to be a closely-wound - almost closed—spiral, and in fact a
really closed spiral when the non-conducting material 6612
was upon it. Of course in this way a restricted radiating surface would be obtained, since the outside of the spiral—the radiating surface—would be largely that which was effective, while the interior of the spiral would be almost shut in, consequently the radiating surface would be limited almost entirely to the outside of the spiral.

6613 265 x-Q. I understood yesterday that your view was that the statement you have quoted in your answer and other statements contained in the samep aragraph, were simply statements of experimental facts. When I attempted to get you to give us the advantage of one of the other statements in the same paragraph as indicating an intended lamp-construction, you refused to do so on this ground; why do you now take one of the other statements and conclude that the patent is
6614 bound to it as a limiting feature in the construction of the lamp, notwithstanding the fact that the drawing illustrates a lamp of different construction and that the specification in those portions which you yesterday said were more descriptive of the actual construction intended to be employed, states that the tar-putty "may be rolled out into wires of various lenghts and diameters"?

A. My present position is perfectly consistent with my former one. I stated that I regarded the state-
6615 ments in the paragraph beginning with line 60, page 1, as showing the results of experiments leading up to the construction of the lamp—a sort of developmental process; the first part referred to a bald statement as to the resistance of carbonized thread, and the second part showed how it was proposed to make use of this carbonized thread in the lamp, the references to the spiral being those later on in the paragraph, the references relative to restricted radiating surface being those in the latter part of the paragraph. My position
6616 now is exactly coincident with what it was before. If the statements at the end of the paragraph referred to do not refer to the lamp and the making of it, then I fail to see of what use they are in the specification. I see no reason why the length should be, however, restricted to a foot. I simply regard the length of a foot as an example of a length to be used to fulfill the requirements. Perhaps in some cases the length might be greater; perhaps in others very much less. If the 6617
statements made in the latter part of the paragraph referred to do not relate to the construction of the lamp, then they are misleading, because no other more definite statements are made when the description of the lamp is carried out further.

266 x-Q. If the burner were coiled as shown in the drawing of the patent in suit, I now understand you, it would not have in a marked degree the disadvantages 6618
which you have enlarged upon in your Answer 8 as arising from the coiled form of the burner. Am I right?

A. If the coil was open, as shown in the drawings, then I think that, in so far as my objections relate to a closely-wound spiral with the turns closely adjacent, those objections would in large part disappear. The other objections would remain. So also would the feature of restricted radiating surface disappear, which is, as I understand it, an object set out in the patent. 6619
So also would the statement made on page 2, beginning with line 52, "with substances which are not greatly distorted in carbonizing, they may be coated with a non-conducting, non-carbonizing substance which allows one coil or turn of the carbon to rest upon and be supported by the other," be rendered also not in accordance with the figures of the patent. Nothing is said whatever of removing such a coating, and the presumption is that it is to remain on the spiral as a permanent support. 6620

267 x-Q. In your 8th answer you speak of the lowering of the vacuum by the yielding up of gases from the burner and its enlarged ends, and you state that there is no procedure whatever pointed out in the specification, whereby this difficulty may be avoided. You refer here, I take it, to the absence in the specification of any statement that the burner is to be heated

6621 by passing an electric current through it during the exhausting process, do you not?

A. Not altogether that, though undoubtedly that would help to drive the gas from the burners. I refer more particularly to the fact that a mass of carbon of the character shown, carbonized at temperatures below the melting point of platinum, would retain a large quantity of gas and be apt to give it up afterwards slowly. Particularly would this be the case if the carbonization was carried on below the melting
6622 point of copper, as when the copper is used to support the turns or to hold them in place during carbonization.

268 x-Q. These gases could be effectively driven out by raising the heat of the burner during exhaustion to a sufficiently high point, and maintaining it a sufficient length of time.

A. Yes, by carrying the incandescence of the burner far beyond its normal, and maintaining it, I think that
6623 this defect might be remedied to a considerable extent, though I think that under the conditions the burner itself would be apt to be injured in the process.

269 x-Q. That is the way it is done at the present time, is it not?

A. I am not aware that it is.

270 x-Q. How are the gases driven out of the clamps at the present time in the practical manufacture of in-
6624 candescent lamps?

A. The deposition of carbon on the joints is made at very high temperatures where the carbon joint is used and contains but very little gas.

271 x-Q. You are now referring to your own manufacture, I suppose?

A. I am referring chiefly to the treated or deposited joint.

272 x-Q. You are not aware of the fact, then, that 6625
the complainant, in the manufacture of its lamps at the present time, cements the carbon to the wires by a carbon cement applied without heating, and that the running on the pumps is wholly relied upon to drive the gases out of this cement as well as out of the carbon burner itself?

A. I have understood that such a process was used, but, as I understand it, the process is somewhat different. The burner, originally carbonized separately, 6626
is mounted on the wires and cemented thereto by a carbon cement. The usual process after this is to carbonize the cement by local application of heat and at a temperature as high as consistent with safety to the joint. Subsequent to this the pumping operation is carried on, and the joint perfected by a carrying of the burner to a very high incandescence while on the pumps. To secure the result, however, it is requisite that even in this case a limited amount of cement be used on the joints so as not to have heavy bodies of 6627
porous carbon existing on the joints, which will retain gas.

273 x-Q. Are you quite certain that you are correctly informed that the complainant, in the manufacture of its lamps, makes a local application of heat to the cement joints?

A. No; it is possible that that step may be omitted and the heating of the carbon itself be relied upon for carbonization.

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274 x-Q. It is a question in your mind of the mass of the carbon at the ends, very largely?

A. Yes, I think the larger the mass the greater the difficulty.

275 x-Q. In this respect, then, you are inclined to hold us to the drawing of the patent?

6629 A. No, not at all, but rather to use the drawing as some indication of what the structure is intended to be. Furthermore, to make such a joint as would not involve too great a risk of its tearing away and leaving the platinum during carbonizing. To do this, the end of the carbon must surround the platinum. I believe the common practice now is to cause the end of the platinum to surround the carbon and then cement the two with a limited amount of cement. Sometimes how-
6630 ever, other metals than platinum are used at this part of the lamp.

276 x-Q. I am afraid that you are misinformed as to what the practice is except in your own factory. An amount of carbon just sufficient to hold the platinum wire tips to the burner during carbonization would be all that the patent in suit would call for, would it not, notwithstanding the indication of the drawing?

A. That I cannot say. I should say that no doubt
6631 an amount sufficient would be sufficient.

277 x-Q. An amount sufficient would satisfy the patent, I mean?

A. An amount sufficient would be sufficient for the purpose, and I would say further that I have not been told just what complainant does in relation to its joints, the practice of the complainant having changed from time to time in this respect. At one time the joints were made by the electroplating of copper over the
6632 enlarged ends of the carbon and the platinum wire. I understand now that the enlarged ends have been abandoned and the cementing process used instead.

278 x-Q. How serious a difficulty is the lowering of the vacuum in an incandescent lamp by the giving off of gases?

A. It is quite a serious difficulty in the lamps requiring comparatively high voltage for their operation. It

affects the degree of incandescence of the carbon itself 6633
by cooling the carbon; it causes disintegration of the carbon, and may give rise to vacuum discharge which is a rapid source of deterioration. It renders the lamp incapable of standing even momentary elevation of electro-motive force. Lamps in which the vacuum is not subject to change can be carried for a short period up to very high degrees of incandescence without much risk.

279 x-Q. Do these difficulties increase or decrease
as the degree of vacuum is reduced and atmospheric 6634
pressure is approached in the lamp?

A. The degree of incandescence rapidly falls off as atmospheric pressure is reached. The economy of the lamp diminishes in like ratio. So far as the vacuum-discharge goes, if the gas be an inert gas, that is, one not containing oxygen, or one not capable of acting upon the carbon chemically, there is a point at which it is difficult to cause a discharge, but this point is a comparatively low vacuum, or one in which there are 6635
sufficient molecules in the lamp to reduce the efficiency. I am quite aware that the several defects do not always follow in the same proportion a change in vacuum. The presence of oxydizing gases driven out into the vacuous space is perhaps the worst condition which can be met.

280 x-Q. Is it not a fact that the gases driven out from the clamps or enlarged carbon-ends into the vacuous space of the lamp are reducing gases and not 6636
oxydizing gases?

A. By no means. It is a well known fact that carbon in a spongy form—a high-resistance carbon for example, such as would be left by carbonization of tar-putty, if exposed to the air after carbonization will absorb oxygen or other gases; that, subsequently heated, it will give out oxygen. It is true that gases given out

6637 during carbonization are reducing gases and that in a certain sense the joint will give out reducing gases, but the oxygen absorbed after carbonization will also come out. I can readily understand that if the carbonization could be carried on without exposure to oxydizing gases, this defect would be obviated, and I gather from the preceding questions that this is done in the complainant's lamps of to-day in which a carbonizing cement is used to fix the carbons without subsequent
6638 carbonization prior to mounting in the lamp.

281 x-Q. Do you not know that it is a well-ascertained and fixed fact—fixed beyond controversy—that the atmosphere present in the lamp-bulb during the heating of the carbons while on the pump is a reducing atmosphere and not an oxydizing one?

A. Yes, that ought to be the case and is the case; but that does not forbid the oxygen in even a reducing atmosphere. For example, if an amount of carbonic
6639 acid exists with four or five times its volume of hydro-carbon gas or hydrogen gas, the gas is still a reducing gas while it has the oxygen in it. The point I make is that the presence of compounds of oxygen with carbon or with hydrogen is a detrimental influence even in the presence of reducing gas. I know as a matter of actual experience that a very slight leak of oxydizing gases, even, into the lamp-bulb in the presence of reducing gases has the detrimental influence pointed out. I know further that carbonized joints exposed to the air
6640 and afterwards exhausted, produce the same effects on the vacuum as does a slight leak into the lamp-bulb. Sometimes, for example, a platinum wire in the draw-plate process has been scratched along its length and the glass has not been fully sealed around it, giving an extremely fine or delicate leak, or the platinum wire has had a crevice in the length by imperfection in the drawing, giving the same exceedingly slight leak. The

effects in such a case are the admission of almost infinitesimal amounts of air, and are the same as are obtained with joints that have been carbonized and afterwards exposed to the air. 6641

282 x-Q. I understand you, however, that a low vacuum, irrespective of the oxydizing action of the gas present, is highly objectionable, especially in high-volt lamps. Am I right?

A. The defect due to low vacuum is chiefly that of 6642
inefficiency in the production of light from the current. If the gas is without action on the carbon and the vacuum be moderately high, the lamp may operate satisfactorily, but the convective influences of the gas may reduce the efficiency.

283 x-Q. How low may the vacuum be and still have the lamp operate satisfactorily?

A. I never experimented to determine that point, simply because the efficiency falls off very rapidly. 6643

284 x-Q. What would you think of it at atmospheric pressure or approximately at that pressure?

A. I have not tried the experiment, and don't think about it.

285 x-Q. You have given the defendant the benefit of many thoughts without trying the experiment. Kindly express your opinion upon this point.

A. My opinion is that if the degree of incandes- 6644
cence was not such as to volatilize the carbon, and the gas was without chemical action, the carbon ought to be stable?

286 x-Q. I refer to the satisfactory operation of the lamp as a practically-efficient lamp. Do you think a high-volt lamp, say such a one as is suitable for multiple arc by any of the present methods of distribution, would

6645 be a practically-useful and efficient lamp, if provided with a non-oxidizing gas at or about atmospheric pressure.

A. I have already said that the efficiency would be very low comparatively to the operation of such a lamp with a vacuous space. I do not think, as compared with the vacuum lamp, that the lamp can be considered as competing in efficiency.

287 x-Q. In your answer to question 8, have you
6646 omitted to call attention to any theoretical considerations, however minute and remote, which you think would further the argument of defendant's counsel as to the impracticability of the lamp-structure which you there considered. If so, please state them.

A. I have made no investigations as to minute or remote considerations; I have stated those things which to me are palpable on the face of the subject. I have sought no farther than this. I have no desire to look
6647 at the subject in any other way than from the practical standpoint.

288 x-Q. Don't you think that you have brought to bear upon the subject in your 8th answer a mental microscope of rather high power?

A. I looked at the patent with the naked eye. No doubt if I had a microscope or a telescope and could analyze all the circumstances connected with the development of the lamp of the patent in question, or if I could bring to bear a mental microscope on the patent
6648 in suit, I might be able to disclose other matters which have not been mentioned. I do not carry such a microscope around.

289 x-Q. Referring to your answer to question 14 is the lamp which you compare in that answer with the platinum lamp of Edison's patent No. 227,229, the same lamp which you had in mind in making your answers 6 and 8?

A. Yes, substantially it is. 6649

290 x-Q. The opinion expressed by you in this answer 14 is based upon certain assumptions, is it not?

A. Yes, it assumes that the accounts given by Mr. Edison in relation to the platinum lamp were correct.

291 x-Q. Have you verified those assumptions yourself by experiment or otherwise?

A. I stated in the second paragraph of the answer
that I had not experimented with platinum lamps made 6650
in this way.

292 x-Q. You know that it is now a fact generally accepted that platinum or platinum-iridium is a material unsuited for the burness of practical incandescent lamps do you not?

A. Yes, I think that with Prof. Houston I pointed out the fact, in the paper read before the American Philosophical Society early in 1879; but the state-
ments of Mr. Edison were based upon a special treat- 6651
ment or preparation of the platinum or platinum-iridium, which special treatment was believed to confer upon it properties so very different from the ordinary metals called by the name as to practically constitute it a different material. I do not know that any statements or recently acquired information in relation to this material puts it on any different basis from the basis it took with Mr. Edison. I do know however, that no such lamps have come into use—at 6652
least so far as I am aware—and I infer from that that either the cost of the process or some other defect must have come into view.

293 x-Q. Taking Mr. Edison's statement as correct, are there not other reasons which make an incandescent lamp with a platinum burner an impracticable lamp, such, for instance, as the low specific resistance,

the extremely small variation in temperature permissible without destroying the burner when it is raised to, an economically high temperature, and the rapid volatilization of the material in a vacuum.

A. These mentioned defects were, it seems to me, the very ones which Mr. Edison had directed his attention, to and claimed to have removed. The fact that the platinum would stand a very high temperature without melting was a point which he brought out, and
6654 this fact, I may say, would be apt to compensate in a measure for the resistance being comparatively low; for the resistance increases with the temperature with metals generally, so that the cold resistance would be multiplied quite a number of times at such high incandescence. Furthermore, he stated that he could get lamps of 750 ohms with the platinum, and the fact is that with carbon substituted, it is difficult to make lamps of a high resistance of anything approaching this, assuming the lamp to be of the normal candle
6655 power. Of course I understand that Mr. Edison may have made a mistake in making these statements in relation to the platinum lamp of his construction, and I freely admit that the defects mentioned in the question may, and probably did exist despite the statements made. I call attention to the fact that Mr. Edison stated that such a burner was absolutely stable at a temperature where nearly all substances melt or are consumed. If this was found not to be so with the specially treated platinum, of course that modifies the conclusion to be drawn.
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Adjourned at 12:45 P. M. for lunch.

Resumed at 2:15 P. M.

294 x-Q. You do not find that Mr. Edison states anywhere specifically that the defects arising from the low specific resistance of the platinum were overcome, do you?

A. I don't remember that he makes any statement in 6657
regard to this fact of low resistance being overcome. The only statement which might bear upon the matter might be the statement that the platinum wire stands a very much more elevated temperature, and it might be inferred from this that the resistance which increases with an increased temperature would continue increasing to a point much beyond what had ordinarily been noted with platinum in its untreated state.

295 x-Q. This however, is an inference and not a 6658
direct statement?

A. It is not directly stated, but I think it must be inferred from the conditions, as the limitation of temperature would be the melting point with ordinary platinum, and up to that point its resistance would have increased continuously as the temperature rose. If the platinum could be carried to a much higher temperature before melting, it would be a natural inference that its resistance would go on increasing in being 6659
raised to that temperature. With carbon the reverse effect takes place up to a certain point, the heating of the carbon at first producing a decided lowering of resistance and at temperatures of very high incandescence, an apparent gain in resistance takes place.

296 x-Q. Do you find that Mr. Edison states specifically that the difficulty arising from the exceedingly small capacity for variation in the temperature of the burner without destruction when it is heated to a high 6660
or economically light-giving temperature, has been overcome?

A. The treatment of the platinum is claimed to give a very much greater infusibility than is the case with ordinary platinum or platinum and iridium, and at the same time a lessened volatility at high temperatures. I quote from the article in question which describes a spiral of platinum prepared by the treatment. "This

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spiral has been kept at the most dazzling incandescence for hours without the slightest deposit becoming visible." This statement means that the spiral is not apt to fuse at very high temperatures and is not apt to volatilize at those very high temperatures. The statement is also made in the paper as follows: "When wound in the form of a spiral, it is as springy and elastic when at the most dazzling incandescence as when cold, and which cannot be annealed by any process now commonly known." Dazz-
6662 ling incandescence in these quotations can but mean a very high white heat, and the inference is that the platinum is not easily fusible by increased temperature. The fact that the metal is claimed to be springy and elastic would seem to me to indicate that it is not near its fusing point. The article calls attention to the action of the treatment on other metals: Alluminium is stated only to melt at a white heat treated in this way, it being a known fact that alluminium is fusible ordinarily at an incipient red heat. While, there-
6663 fore, it is not distinctly stated that the difficulty of small range without fusing is overcome, yet the statements I have quoted can but mean that the platinum or platinum and iridium, as compared with the metal known before, was free from this defect, or at least so free as to stand the most dazzling incandescence without melting.

297 x-Q. You have referred to the statement in the Edison patent No. 227,229, that the burner would have
6664 a resistance of 750 ohms when incandescent. What would be the length of a platinum wire required to give this resistance, taking the diameter of five-thousandths of an inch, as stated in the patent, as the size of the wire?

A. That I have not calculated, and in fact it would be necessary to have a statement of the temperature to which it was heated, or, in other words, the degree of

incandescence, before it could be even approximated. 6665
And, besides, the resistance of platinum and iridium is different from that of platinum, and varies according to the composition of the alloy. Unless the data of specific resistance of the metal was given, I do not see how there is any way of getting at it. Of course if the specific resistance of the alloy used were known, as heated to the incandescence mentioned, it would not be a difficult matter to calculate the length required when the diameter is given, the given diameter being 6666
five-thousandths of an inch.

299 x-Q. In your sixteenth answer you have referred to the French patent of Gaudnin; at other points in your deposition you have quoted freely from the record in the case of the Consolidated Electric Light Company against the McKeesport Light Company, decided by Judge Bradley, a copy of whose opinion is appended to the complainant's *prima facie* record. Please state whether or not the Gaudnin French patent 6667
formed a part of the record in that case?

A. Yes, it did.

300 x-Q. You have referred to the English Provisional Specification of Scott, No. 851, of 1878; what is the character of the electric light referred to in this specification?

A. The character of the light is something similar to the arc light.

301 x-Q. You have also referred to the English 6668
patent of Pulvermacher, No. 4,774, of 1878; is it not a fact that in this patent, carbon conductors are only described in connection with arc lighting, while for incandescent lighting, platinum is referred to as the material of the burner?

A. Yes, that is the fact. I simply referred to the

6669 patent as indicating a method of making a carbon spiral.

302 x-Q. In your answer to question 18, and in criticising Prof. Barker's statement that, upon the appearance of the patent in suit, it was generally recognized that Mr. Edison had solved the problem of the practical subdivision of the electric light, you state that you do not see how this can be so "since no exhibition of lamps made in accordance therewith was to be
6670 seen." Is the character of the lamp you had in mind in making this answer, the same lamp you had in mind in making your answers to questions to 6 and 8?

A. The lamp I had in mind was a lamp made in accordance with the specification of the patent in suit, and therefore is in many respects the same lamp as dealt with in the questions mentioned.

303 x-Q. You had in mind a lamp which would have the defects you have called attention to in your
6671 answer 8, did you not?

A. I had in mind the legitimate outcome of the attempt to use the patent as a guide in producing a lamp, and if it had those defects, of course I had in mind the existence of them in the description.

304 x-Q. You excluded, however, lamps with improvements in detail not described in the patent in suit?

A. I excluded lamps made on a different plan, although
6672 I see no reason to modify my general conclusion concerning any lamps.

305 x-Q. This is a question of fact with regard to exhibitions of lamps. You recollect that Mr. Edison's lamp was on exhibition at the date of the issue of this patent, but I take it that you did not include that lamp because you considered that it contained improve-

ments not described in the patent in suit; am I 6673
right?

A. Yes, I believe that other lamps were exhibited about the time of the issue of the patent in suit, which were constructed by a process quite different from that laid down in the specification of the patent in suit, and I naturally excluded these lamps in saying that no exhibition was made of the lamps constructed in accordance with the patent in suit.

306 x-Q. You have quoted with considerable unc- 6674
tion in your answer 18 an article from the Telegraphic Journal of October 15, 1878, from which you conclude that the lamp Mr. Edison had at the time of the panic in gas stocks caused by the announcement that he had succeded in subdividing the electric light, was an entirely different lamp even from a platinum lamp or a carbon lamp. What kind of a lamp do you take it the article you have quoted refers to?

A. I take it to be the lamp illustrated in figure 14 of the French patent before referred to, namely, that 6675
of the 28th of May, 1879, No. 130, 910, which is described to be a lamp in which the light is produced by the electric spark which renders indandescent some chalk which has been prepared in calcining acetate of calcium, the chalk being placed in the tube between two metallic discs; as it is very light and porous, the very smallest sparks are stated to bring it into the state of vivid incandescence. The reference to a Ruhmkorff coil in the statement which I am credited with bringing out with so much unction, simply confirms my 6676
impression that I am correct in saying that this lamp is the lamp referred to in that statement; at least it is the only lamp which would be suitable for the production of light, however imperfectly, by turning the handle of a Ritchie induction coil, found in any of the published statements or patents which Mr. Edison took at or about that time or sometime thereabouts. It is the

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only one which, as described, would give consistency to any statement about lighting a large fraction of a large city by an extremely small amount of horse-power, for it is stated that the smallest sparks can bring it to the state of vivid incandescence, it being well understood that small sparks cost very little in energy.

307 x-Q. You never know yourself nor were you ever informed credibly of Mr. Edison's having exhibited at
6678 his laboratory or anywhere else a lamp of this character?

A. No, I don't think I ever heard of its being exhibited; but when I first heard of the statements that light was to be produced by turning the handle of an induction coil, I guessed at what it was and tried the experiment, putting magnesia into a glass tube and passing discharges through it from an induction coil. It didn't work. Although the light was given for a few moments, it rapidly ran down until nothing was left
6679 but the spark.

308 x-Q. This article which you have quoted in your answer 18 is absurd on its face, is it not?

A. Well, the statements certainly are. The article I do not know anything about. I do not know the circumstance which gave rise to it or I could pronounce upon the absurdity or non-absurdity without question.

309 x-Q. For all you know, it is the product of the
6680 imagination of the reporter?

A. I do not know what it is the product of. It may have been partly the imagination of a reporter having something of a foundation to proceed upon. It may have been the result of over-enthusiasm about an untried and unproved experiment.

310 x-Q. Or, as I suggest, it may have been a purely imaginative composition for aught you know?

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A. It may have been but I do not remember seeing any denial of it at the time; it was allowed to stand for what it was worth, I think, but I wish to be understood as being distinct on one point—I know nothing about its source. I cannot say whether it is imaginary or not.

311 x-Q. The effect of an article of that kind, if given credit, is to make Mr. Edison appear ridiculous in the
eyes of scientific men, is it not? 6682

A. No; if the article had been true it would have had just the reverse effect; that is, if what had been claimed to be accomplished had been accomplished it would have had very much the reverse effect.

312 x-Q. I mean that the use of the article *now* when we know that it is not true—that it is absurd on its face—the giving of it credit has the effect of making Mr. Edison appear ridiculous?

A. I certainly in quoting the article had no such in- 6683
tention myself; I honor Mr. Edison too highly for that. I simply alluded to the article as one step in the history of the effect of the announcement in relation to the development of a new system of lighting which was to be generally available and cheap; that is all.

313 x-Q. This article is credited by the *Telegraphic Journal* to the *New York Sun*, is it not?

A. I believe it is, although I have not the *Journal* 6684
here now to refer to for confirmation.

314 x-Q. That same article is printed in Mr. Pope's book on the Evolution of the Electric Incandescent Lamp, as having appeared in the *Sun* of September 16th, 1878, is it not?

A. Yes it appears to be the same article.

6685

315 x-Q. Have you ever read or looked over this portion of Mr. Pope's book entitled "The Early Efforts of Edison"?

A. I think not.

316 x-Q. Mr. Pope you know to be employed as one of the experts for the Westinghouse Company which is a competitor of the Edison Company, do you not?

Objected to as immaterial.

6686 A. I understood so, although I have no positive knowledge of the fact.

317 x-Q. Please look at the portion of Mr. Pope's book entitled "Early Efforts of Edison," in which this *Sun* article and other newspaper articles are collected, and state if it does not appear that these articles are there used for the purpose of making Mr. Edison appear ridiculous in the eyes of the reader of Mr. Pope's
6687 book?

Objected to as immaterial, because it does not appear in evidence what the articles are and because it does not appear that the witness is competent to give an opinion upon such a question.

A. I do not think that I ought to be called upon to state what these articles are for, or what they were written for; in fact I know nothing about the motive
6688 at all. I do remember that the articles quoted did appear, and credited Mr. Edison with certain statements and claims as to what he was doing or proposed to do. Of course I can say that I recognized at the time of the appearance of the article that many of the statements made could not be substantiated, and were either wrongly reported as coming from Mr. Edison, or the result of an over-enthusiasm. That any of these statements had a bad effect on gas stocks, of course I

do not take into consideration; because this would 6689
simply indicate that the holders of gas stocks were not so wise as they should have been at the time. Mr. Edison, perhaps, did not consider the statements worth denying, though of course I know nothing about this either. In the nature of things I was not in a position to know just what provoked the publications or how far they were likely to be substantiated, except in certain particulars.

318 x-Q. In the criticism of Prof. Barker's statements 6690
as to the embarking of capital in the incandescent electric lighting business after the grant of of the patent in suit, you have referred to the fact that the first central-station plant of the Edison company was not begun until later than April, 1882. Did you inform yourself about this fact before making the statement?

A. The statement was made in accordance, as I understand it, with the bulletins of the Edison Company and with the testimony of Mr. Edison in the 6691
McKeesport suit. Of course as to taking any steps to start a station of this kind, that would be almost impossible for me to discover. My answer refers, of course, to those conditions of affairs which led up to the establishment of the running of the station in September, 1882.

319 x-Q. That is, you mean actual work of construction visible to the public?

A. Naturally so.

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320 x-Q. Did you look through the Edison Bulletins to verify your statement?

A. I took the statements as found in the Bulletins in making my answer.

321 x-Q. You must have overlooked then, the statement contained in the first Bulletin under date of January 26th, 1882, that "between six and seven miles of

6693 street mains have thus far been laid in the down-town districts"?

A. I did not notice that statement, and, in so far as my answer is not consistent with the statement, I will, course, modify it.

322 x-Q. You do not know, of course, how much earlier than this the financial arrangements were made for constructing this central station?

A. No.

6694

323 x-Q. In making your statements as to the time when capital was embarked in the development of the Edison Electric Lighting business, you did not inform yourself as to the real facts in the case; you were not in a position to do so, and did not do so?

A. Outside of the facts at hand, of course, I had no direct means of determining the point. I remember distinctly that discussions were frequent as to the cost of laying conductors, and that it was soon recognized
6695 that the distance which could be covered without excessive cost was very small. I know that the outlook for the embarkation of capital was not encouraging in many respects, in so far as central station lighting plants were concerned, chiefly on account of the cost of distribution.

324 x-Q. Don't you think that in criticising Prof. Barker's statements as to the embarkation of capital in the Edison business, it would have tended to keep
6696 the truth from obscuration, if you had informed yourself about the facts, or, not being in position to obtain the information, had omitted to attempt to state the facts?

A. I think the difficulty is that Prof. Barker's statements are overdrawn. Perhaps an averaging-up process would be legitimate in this connection. Prof.

Barker connects the embarkation of capital with the 6697
issue of the patent in suit. It issued January 27th 1880. The meaning of my statement is briefly this: That I do not think that the issue of the patent in suit had the effect ascribed to it by Prof. Barker. There were a great many other influences which had to determine that matter, and, in fact, did determine it. I simply endeavored to state the facts as I knew them, relying chiefly upon the data available, as found in the Bulletins of the Edison Company, and my recollection of 6698
the matter itself.

325 x-Q. In stating that the first Edison central-station plant was started in operation in September, 1882, which fact you gathered from the Edison Bulletins, as I understand it, you overlooked the statement made in the Bulletin of May 15, 1882, which shows that the Holborn Viaduct central station of the Edison Company was in operation on April 13, 1882, did you not?

A. I had not connected the work abroad with the 6699
subject, because the patent in suit is a United States patent, and if the patent in suit was to have effect, it seems to me that it must have effect in the United States.

326 x-Q. Are you aware of the fact that the Holborn Viaduct station was supplied with apparatus built in this country?

A. No.

327 x-Q. You did not look far enough in the Bulletins to find that out? 6700

A. No, I did not look concerning matters nor the establishment of any stations abroad.

328 x-Q. You held no such relations with the Edison Electric Company at that early period of the business

6701 which would have enabled you to keep informed as to the progress of the Edison business?

A. Not further than its outside manifestations were perceptible.

329 x-Q. Did you look through these Bulletins yourself for the facts you have collected in your answers 19 and 20, or were you handed the particular Bulletins by defendant's counsel and had pointed out to you the portions upon which they wished you to rely in making
6702 your statements?

A. I did some looking myself and some passages were pointed out.

330 x-Q. In the progress of the incandescent electric lighting business it is a fact, is it not, that, due to the large amounts of capital required for the building of central-station plants, the business was first more largely developed for isolated lighting or the lighting of separate buildings by their own independent plants?

6703 A. Yes, I think that the large amount of capital required certainly did restrict the growth of central-station work, and I seriously think that it would have grown but slightly but for improved methods of organization and distribution of currents. The facts are simply these: That the incandescent lamp was found in practice to be limited in its capacity for distribution; that is, if a lamp fairly durable was taken into account, that the calculated cost of mains for a district in a town or city was found to be very great—so great in-
6704 deed, that the districts had to be limited or circumscribed in their area to within comparatively narrow limits.

331 x-Q. What is the fact at the present time with regard to the relative number of incandescent electric lamps in use in this country for isolated lighting and for central-station lighting?

A. I have never made a direct comparison--but I suppose that the isolated lighting would run to pretty high figures and that without distribution in improved ways, the central-station lighting would have been far more limited than it is. 6705

332 x-Q. Do you think that there are more incandescent electric lamps used in multiple arc at present in this country for central-station lighting than are used in multiple arc for isolated lighting?

A. I did not say so; I said I did not have any 6706
figures which compare the two. I simply made the statement that central-station lighting with the lamps in multiple arc from the mains carries its own restrictions.

333 x-Q. What, approximately, do you think is the relation in numbers between incandescent electric lamps used at the present time in multiple arc for isolated lighting, and those used at the present time in multiple arc for central-station work with all sys- 6707
tems of distribution using the lamps in multiple arc. I refer to this country.

A. The question includes practically the incandescent lamps, however used, with the exception, I suppose, of series lamps; is that it?

334 x-Q. Yes, it does.

A. I would say that I have no data at command on which to base an opinion which would not be subject to amendment, even to a large percentage; in fact, I 6708
do not know whether any estimation of the numbers has ever been made that could be relied upon for accuracy. I would say, however, that perhaps it would be fairly correct to estimate the lamps in isolated lighting to be not far from, or to approximate, to not a wide extent—the number used in central-

6709 station lighting by all kinds of distribution contemplated in the question.

335 x-Q. And earlier in the business the isolated plants contained the larger number of lamps, did they not?

A. Yes, I believe that is true.

336 x-Q. Would you be surprised to learn that as
6710 late as August 1st, 1886, the Edison Electric Light Company's plants included in isolated plants 181,463 lamps, and in central-station plants 149,900 lamps?

A. No, I would not be so surprised. I think I have pointed out the reasons why central-station lighting on the plan contemplated by Mr. Edison in the patent in suit and in his prior platinum lamp patent, would naturally restrict itself, and that it would require for its extension other methods of distribution than the
6711 multiple-arc system contemplated.

337 x-Q. When was the first isolated plant of the Edison Electric Light Company put into operation?

A. I do not think I know precisely. My impression is that it was a steamship plant, put in some time—if I remember at all correctly—in the steamship Columbia late in the spring or early in the summer of 1880, perhaps.

338 x-Q. You did not look far enough in the Bulle-
6712 tins to find this out?

A. Yes, I believe I noticed the fact, but it is two weeks since I saw it, and I now cannot guarantee the exactness of the statement.

339 x-Q. I show you No. 4 of the Bulletins for Agents of the Edison Company for Isolated Lighting. Refreshing your recollection from this Bulletin, when

was the date of starting the Columbia or first incandescent isolated plant of the Edison Company? 6713

A. It is stated to have been started May 2, 1880.

340 x-Q. You do not know how much earlier than this date the work of putting in the plant in the steamship was commenced, do you?

A. No.

341 x-Q. Taking the lapse of time between the issue 6714
of the patent in suit and the starting of this Columbia plant, how favorably does this compare with the development of the arc-lighting business with which you were connected?

A. It is a difficult matter to compare. Sometimes patents do not issue until a long time after the starting of the plant, and some of the arc-light lamps were no doubt in operation long before the patents issued. In a general way I should say that the starting of the plant on the Columbia was very much the same as 6715
the starting of an arc-light plant, so far as it was related to the patent.

342 x-Q. Take your general, although imperfect, information as to the history of the development of the Edison incandescent business, and compare it with the progress made in the development of the arc-lighting business with which you were connected, and state whether or not the progress of the Edison incandescent business was reasonably rapid for a new industry 6716
and one requiring the investment of large amounts of capital?

A. Comparing it with the arc-light business with which I was connected in the early days, I would say that this involves a comparison with something which did not grow at all, practically speaking, within the first two years of its establishment. I have no reason to question the fact that the incandescent business did

grow and grow with fair rapidity in the hands of the Edison Electric Light Company, but I do not see how it emphasizes the matter at all to compare it with the growth of an organization which I have already characterized as without enterprise, until it fell into the hands of a different management. Our arc-light business I might add, was at one time bought up and controlled by the Brush Company and practically throttled, and it was only on recovering it from this condition that it took the start and grew.

6718 Adjourned at 4.45 to Thursday, Feb. 20th, 1890.

Boston, Mass., Feb. 20, 1890.

Met pursuant to adjournment.

Counsel present as before.

343 x-Q. Do you refer to central-station lighting over large areas in your answer to question 26?

A. Yes, over considerable areas such as lamps are now used upon in multiple arc from the central stations.
6719

344 x-Q. The two Defendant's lamps referred to in your answer 26 would be suitable for central-station lighting in multiple arc over limited areas, even with the restriction as to the methods of electrical distribution contained in the question?

A. The areas would be very limited indeed, so limited as to hardly merit the name of central-station lighting. I have no hesitation in saying that distribution in multiple arc would practically not have been
6720 done from central stations if lamps of the resistances mentioned were the only ones available. There would, in fact, have been no business of distribution established in my opinion on any such basis.

345 x-Q. That is, your idea is that as a business measure more stations of distribution would have to be used than the profits of the business would support?

A. Yes, that is my idea in part; or further, that if 6721
the same number of stations were used, the enormous size of the conductors would be prohibitive, the distance to which the current could be carried economically being limited indeed, and thus unless by the use of extremely large conductors.

346 x-Q. What areas, do you think, could be covered from central stations by lamps of the voltage of the two defendant's lamps referred to. Please state it 6722
as a circular area about the station?

A. I will assume of course that the lamps are pretty evenly scattered over the area; then I should say that the distance would be limited probably within an area of about from one-eighth to a quarter of a mile radius, with the lamps of say 79 to 80 ohms; but even this estimate would require very liberal allowance in regard to main conductors. With the lamps of about 40 ohms the distance would be very much more limited—less than half probably. I have made no estimate in 6723
figures, but this is my general judgment of the matter.

347 x-Q. These lamps, however, are entirely suited for use in large numbers in multiple arc for isolated lighting, and have been and are so used to a large extent by the defendant company?

A. The lamps of 79 or 80 ohms would be suitable for isolated lighting provided the distances were not excessive; but the lamp of 40 ohms would be much more limited or restricted in this respect. It would 6724
probably be necessary in using any large number of such lamps to distribute from two or more separate points to avoid undue expense in the conductors or loss in them.

348 x-Q. But even the lamp of 40 ohms resistance hot could be and is operated in large numbers in multiple arc from the same dynamo?

6725 A. The question is misleading. So far as central-station work goes, the lamps are not so operated; but so far as isolated work goes, they may be operated directly in multiple arc from the dynamo, provided of course we understand by the term "isolated" that the conductors are limited to an area say of a building, or to an area of very moderate dimensions.

349 x-Q. Don't you know that this lamp of 40 ohms
6726 resistance hot has been put out in enormous numbers by the defendant company for use in multiple arc for isolated work, and is still used to a large extent for that character of work?

A. No, I don't know that that is the fact at all; in fact I have reason to believe that it is not so.

350 x-Q. Prior to the commencement of this suit in May, 1885, did the defendant, The United States Electric Lighting Company, sell plants for isolated work or
6727 have them in operation?

A. Yes, I believe they did.

351 x-Q. Do you know that the company had any central-station incandescent plants at that time.

A. No, I do not; I know nothing about the business of the company in that respect.

352 x-Q. But you understand that they had at least a number of isolated plants established employing in-
6728 candescent lamps in multiple arc?

A. Yes, I have understood so.

353 x-Q. Are you prepared to say that in the isolated plants of the defendant at that time these 40 ohms lamps were not more largely used than the 80 ohm lamp?

A. No, I do not think that I could make that state-

ment positively, because I had no occasion to investi- 6729
gate the question. I only base my opinion in regard to this matter on what I regard as likely to have been done. It is, of course, quite possible that a number of plants using 40-ohm lamps may have been put in operation.

354 x-Q. Don't you recollect the fact that defendant company started out in its business by making lamps of the lower resistance and established its earlier isolated, multiple-arc plants with such lamps; and that 6730
the lamps of the higher resistance were a later manufacture of that company?

A. In general I have understood that the lamps used were comparatively low-resistance lamps with low-resistance carbon conductors; that the conductors were treated by depositing carbon upon them which reduced their specific resistance and their total resistance. I of course understand also that lamps of other resistances have been made by the defendant company. Just what proportion of lamps of the one resistance or 6731
another I cannot say. I have no means of determining just when any changes in resistance were introduced or changes in the construction of lamps.

355 x-Q. As a matter of general information, however, is it not a fact that the defendant company commenced to manufacture lamps of the lower resistance, and did isolated business with these lamps arranged in large numbers in multiple arc?

A. It may be the fact; I think it probably was the fact. 6732
I remember seeing some lamps, known as Maxim lamps, as early as 1880, which had a comparatively low resistance, both as to the character of the carbon and the lamp also.

356 x-Q. Do you not understand that the general fact is as stated in my last question?

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A. I think it may be; I have no definite information on the point.

357 x-Q. Do you not understand that it is the fact—not that it may be?

A. Since you have called up the question I am willing to admit that it probably was the fact. I do not know, however, of any means of knowing just when the defendant company made lamps of any particular
6734 resistance, or when such lamps were introduced into their plants. That is the only reason I say, it may be.

358 x-Q. Even at the present time, what is your understanding of the relative business done by the defendant company in numbers of lamps for isolated plants and for central-station plants, with lamps in both instances arranged in large numbers in multiple arc?

A. I have not investigated the matter at all; in fact
6735 I do not know anything about the present business of the defendant company. I understand the defendant company is controlled by another company which does a business of central-station lighting, but I know nothing as to the relations one with the other, as to the apportionment of the work or anything of that kind. I have never been informed.

359 x-Q. You refer now to the Westinghouse Electric Company I assume?

A. Yes.

6736

360 x-Q. Returning to your 20th answer in which you speak of the Edison station at Brockton, Mass., as started in 1883, did you examine that plant yourself?

A. Yes, I remember visiting the plant shortly after it was started.

361 x-Q. This was before your company went into the incandescent business, was it not?

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A. Yes, it was shortly after the arrangements for the removal of our business to Lynn, Mass., were put under way. I remember the occasion chiefly because Mr. Edison was there at the station and that the system of distribution had been modified into a "three-wire" system, as it is termed, and Mr. Edison made the remark that notwithstanding the saving of copper attained thereby—pointing to the underground conductors, that that was where the money went, and that was the great difficulty they had in establishing plants. 6738
I do not say that these were his words but the remark he made meant that.

362 x-Q. Did Mr. Edison treat you courteously on that occasion and offer you facilities for an examination of the apparatus?

A. I made no examination of the station at all, simply exchanged a few words of greeting and a few conversational remarks. Mr. Edison was very courteous as I have always found him. He invited me into the station 6739
where the dynamos were running. There was no particular need of his offering any facilities for an examination of the apparatus other than the ordinary one of looking into the station and watching the dynamos turning, with the engines driving them. I was quite familiar with the general details of such a station, and made no special examination of any kind. I simply glanced into the room. Our time was occupied as I remember it, in a little front office mostly in general conversation.

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363 x-Q. Referring to the carbon incandescent lamp with the V-shaped burner referred to by you in answer 29, have you ever seen such lamps in use; if so where, when and to what extent?

A. I saw them in the months of June and July of last year, chiefly in London as also in Paris. They were also to be seen at the Exposition in Paris as I

6741 distinctly remember passing by a plant of them in operation, but as I had already noticed them in use for actual lighting of buildings in London, the subsequent occasions did not impress themselves particularly upon my notice. Just what buildings in London I saw them used in I do not recollect, though my impression is that they were used to a considerable extent in some of the larger hotels or public buildings. I saw them on several occasions in use and on several occasions while in London in use there, and on my return from
6742 Paris. I do not know to what extent they have been put into use.

364 x-Q. Nor do you know their degree of economy in operation or durability?

A. No, I know nothing of the data connected with the operation; they seemed to be, however, working very well. The lamps appeared to be in good condition and working at a very good incandescence, and I remember that one of our agents in London had
6743 said to me that they appeared to him to be giving very good satisfaction. Farther than this I have no knowledge on the subject.

365 x-Q. Are any lamps of this kind in use in this country, that you know of?

A. I have not seen any here.

366 x-Q. Referring to your answer to question 30, did you ever test the improved dynamo-electric ma-
6744 chine brought out by Mr. Edison in 1879, and described in the "*Scientific American*" of October, 1879?

A. Yes, I made such a machine in 1876, differing in no substantial respect from the one in the figure. It was a wooden bobbin wound over with iron wire for receiving the coils of the armature, which were Siemens-wound. The field magnets were the plain horse

shoe, standing vertically on the pole pieces. I tested 6745
the machine at the time it was made—that is, 1876. I had not tested in that year any machine built by Mr. Edison of the same general type. I have tested the same type of machine with improvements more recently. The chief difference between my machine and the one referred to was in the length of the field magnets. Mr. Edison's machine was characterized by extremely long field magnets which have been cut down more recently, as it was found that this extreme 6746
length was not attended with any gain in the action.

367 x-Q. Are you prepared to say that this machine which Mr. Edison had in 1879 was not capable with a steady driving power, to give currents without material fluctuations?

A. No, on the contrary, with a steady driving power the machine would undoubtedly give very steady currents, if the commutator bars are sufficient in number and the brushes on the commutator are kept 6747
in good condition. The difficulty I referred to was not so much that a machine could not be made to give steady currents, but that the driving power ordinarily obtainable was subject to fluctuations. I would say in this connection that the development of electric lighting has undoubtedly had a wonderful effect in improving the character and steadiness of steam engines.

368 x-Q. It was a question then, of steam engineering rather than of electrical engineering—I mean this 6748
matter of steadiness referred to in your answer 30?

A. Yes, it was certainly by far a question more of steam engineering than of dynamo construction. The comparative slow speed of engines and the lack of closeness of governing were the chief difficulties met. The strokes of the engine were apt to be noticed in the speed of the dynamo and consequently in the current

6749 and if the governor did not act very promptly and with great delicacy, the engine would vary its speed through longer periods and so cause fluctuations. Much of this difficulty was removed by the introduction for electric lighting purposes chiefly of what is known as high-speed engines with delicate governing appliances; also by the increase of weight given to the fly wheels of engines intended for driving such machinery as dynamo machines.

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369 x-Q. Referring to the Pea lamp about which you have testified in questions 31 and 32, do you think this lamp was intended for central-station distribution?

A. No, I have nowhere indicated that I have thought so.

370 x-Q. As a matter of fact this lamp is one used with a battery for surgical, dental, or merely toy purposes, is it not?

6751 A. Yes, the lamp is constructed to be operated by a battery usually. It is in fact a diminutive lamp. Its resistance, its size, and everything about it being diminutive just in the same sense that the Sunbeam lamp which I referred to was not diminutive, but on the other hand a very large lamp. Of course it is possible to enlarge or diminish, I suppose, to almost any desired extent. The question which called forth my answer in respect to the Pea lamp was, whether that lamp was adapted for use in multiple arc in large numbers in any general system of electric lighting, and

6752 I explained why it was not.

371 x-Q. Referring to the Edison municipal lamps, which you speak of in answers to questions 32½ and 33, when did you first see these lamps?

A. I do not recollect; two or three years ago, I think, possibly a little more.

372 x-Q. These lamps are adapted for use in large numbers in series or multiple series, are they not? 6753

A. They are adapted for use in series and in multiple series, the difference between multiple series and series being, as I understand the question, that in the latter a number of series are run from one source.

373 x-Q. These two arrangements of electrical apparatus were known at the date of the patent, were they not, and long before?

A. Yes, so far as general electrical connections of apparatus goes, they were known as circuit arrangements. 6754

374 x-Q. Referring to your answer 35, the view which you and Dr. Morton take of the lamp with the carbon burner, described in the King patent, that is, the modified apparatus which is spoken of as applicable to submarine lighting, necessitates the disconnection or separation of the mercury reservoir and the column of mercury from the rest of the apparatus, does it not? 6755

A. Yes, a procedure which is quite simple and easy to accomplish, and would have been understood by anyone in working these sealed chambers for vacuum purposes.

375 x-Q. Is it specifically stated anywhere in the King patent that this lamp for submarine lighting is not to be provided with the mercury reservoir and column?

A. No, I see no necessity for any statement specifically to that effect; it would be simply ridiculous to lower the mercury column under the water and have the lamp sealed off at the same time. Beside, I understand that the words "suitably sealed" are sufficiently definite to give anyone with the slightest knowledge full information as to what should be done, especially taken in connection with the first sealing mentioned in 6756

the patent in regard to the platinum wire entering above.

376 x-Q. Taking the first description of the lamp with the carbon burner, is it not a fact that the complete apparatus will comprise a cup or reservoir containing mercury, into which the lower end of the barometer tube dips?

A. Certainly; the barometer tube being of a length sufficient to secure a vacuum in the upper part, its
6758 lower end will, as in the barometers, dip into the cup of mercury.

377 x-Q. Now what would be the objection to lowering this apparatus, just as described, beneath the surface of a body of water for submarine lighting, assuming, of course, that the cup is so supported from the tube that it won't fall off?

A. The objection would be that after it had got about a foot or two under water the mercury would fill the
6759 lamp bulb partially, and the further lowering would fill it up completely with mercury, so that there would be no vacuous space. Another objection would be that it would be very difficult to prevent the mercury spilling out of the cup in these operations.

378 x-Q. That is to say, the water pressure being greater than the air pressure, and the water pressure being exerted on the surface of the mercury in the uncovered cup or reservoir, the mercury would rise in
6760 the lamp and the degree of vacuum be diminished and the lamp eventually filled with mercury?

A. No, that statement is not quite correct. It would be more correct to say that the water pressure is exerted in addition to the air pressure, and by that means the mercury lifted 30 inches by the air pressure is lifted further by the air pressure plus the water pressure, and eventually would fill the lamp.

379 x-Q. Now, wouldn't the objection of the spilling 6761
of the mercury as well as the objection arising from the pressure of the water directly on the mercury, be overcome if the cup or reservoir were suitably capped over or closed by a cap which would exclude the water pressure?

A. Yes, provided the cap did exclude the water pressure which would be very considerable when the apparatus was lowered to a depth such as would be likely to be used for any submarine lighting, and provided further the cap was arranged to allow the electric wire 6762
to pass through it for connecting the other terminal or lower terminal of the lamp. How to make such a cap fit around the tube so as to be tight under the conditions is to my mind a very different procedure; and I do not think that it need be more than suggested to show that it is not the procedure which is in any way contemplated in the patent. I think the very absence of any mention of a cap covering the cup, and the mention of the sealing, is conclusive on this point. Certainly to a mechanic the roundabout pro- 6763
cess which is assumed in the question would hardly be likely to present itself. It is perfectly well known that a lowering of such a receptacle to a moderate depth means the exertion upon it of a very great pressure, in addition to the atmospheric measure; that the apparatus must not be permitted to leak water, and that to do this effectually would require that the cup be melted on or sealed glass to glass with the wire carried through it. Now I submit that there is no need at all for making the assumption of the question. The 6764
language is so simple—so plain as not to involve any roundabout process, and the sealing referred to, in my opinion can but mean the sealing which had been referred to in connection with the other terminal of the lamp.

6765

380 x-Q. You protest too much. I asked you a simple question, and expected a simple answer. I did not ask you to admit the correctness of my assumption, nor do I expect you to, but I expected an answer to the question as asked. Please give me one.

A. I gave the answer, and, further, I assumed, in answering, that the desire was to accumulate information for the benefit of the Court in relation to this question. If I overstepped the limits of the
6766 question in doing this, I am not aware of it. The first part of my answer is definite and precise as an answer to the question.

381 x-Q. If the mercury cup or reservoir employed were of metal, and were capped over so as to exclude the water pressure from the mercury, the electrical connection could be made to it outside of the cup, could it not, and the wire would not have to pass through the wall of the cup?

6767 A. I do not know that I understand the question. It is not full enough in stating the capping process without my making assumptions which are not in it.

382 x-Q. I did not ask you to assume anything about the capping process; I simply want to know if it is not true as a simple, direct fact that if the mercury reservoir were of metal, the circuit wire would not have to pass through the wall of the cup in order to complete the circuit, but might be fastened to the
6768 outside of the cup so long as it made a metallic connection with the cup.

A. Yes, the question then resolves itself into merely this inquiry: Whether a metal cup will conduct a current from the outside to the inside. I say, of course, it will.

383 x-Q. Do you think a mechanic would have any difficulty in providing an annular cap for such a cup,

which would be sealed to the cup, so as to effectually 6769
exclude the water pressure, and would be sealed to the glass tube where that tube passes through it, so as to effectually exclude the water pressure?

A. Yes, I think he would have some difficulty. I do not think in the first place, that a mechanic would make a cap for the cup in such a case; he would be more apt to make the cup and cap as one piece, or make them practically one piece. The difficulty I see about the matter is the effectual forming of the joint to resist 6770
pressure between the glass tube and the metal and the difficulties also of such arrangement in relation to the passage of current. The cup would have to be insulated and the wire leading to it, all over, or if not insulated it would require a careful insulation of the conductor attached to the other wire for obtaining satisfactory results. I do not however, understand the word "sealing" as having any reference to the case assumed in the question. I do not think that a mechanic would understand the word in this connection 6771
as referring to the operation assumed in the question

Adjourned for lunch at 1 P. M.

Hearing resumed at 2 P. M.

384 x-Q. With the construction which you give this statement of the modification in the patent, the insulation of the conductors would have to be made, would it not?

A. Oh certainly, only there would be much less sur- 6772
face to so protect.

385 x-Q. That is, in the case of the construction as you assume it, as well as in the case of the construction which I assume the description to mean, the thorough insulation of the wire leading to the upper end of the lamp-chamber would secure the desired results?

6773

A. Yes, if one of the wires were perfectly insulated so that no leakeage could occur, it is undoubted that the current would be fed without any difficulty to the lamp.

386 x-Q. If the mechanic in providing a cap for the mercury cup would make the cup in one piece, with the cup as you suggest he would more probably do, than to make the cap a separate piece from the cup, then the difficulties in closing the apparatus against
6774 the water pressure would reside entirely at the joint between the glass tube and the cap where the former passes through the latter?

A. No; I think there would be other difficulties in addition. I think it would be necessary to construct a metalic framework for the whole lamp so that the glass tube in entering the cup would not be disturbed in position or be apt to be broken. I regard the cup as involving other features not even hinted at. It must be remembered that the body of mercury and the
6775 metallic cup assumed would add considerable to the weight and tend to drag heavily on the end of the glass tube so that some arrangement would have to be made for supporting the lamp in a vertical position at all times, and lowering it from the top of a metallic frame. As nothing of this kind is hinted at, it seems to me that the question would be incomplete if not involving these other things in the consideration.

387 x-Q. The frame and weight we will return to by
6776 subsequent question. So far as producing a joint is concerned which would exclude the water pressure, the difficulty, as I understand you, would reside at the joint between the glass tube and the cap; am I right?

A. Yes, assuming the cup to be placed on the end of the glass tube, there would be required a joint for resisting high pressures of fluid where the cup and tube came together.

6777

388 x Q. Would not the ordinary gland or stuffing-box joint which was used for steam-boiler water gauges before the date of the King patent for making a joint between a glass tube and a metallic cap on its end, be a suitable construction for excluding the water pressure?

A. Yes, I think such a joint if properly made might answer, but I think it would be called a packed joint and not a sealed joint. It would be necessary that it be made very firmly and tightly around the tube to stand 6778
the very high pressures without leakage.

389 x-Q. Such joints at the present time stand high steam and water pressures without difficulty, don't they, as high as 150 pounds for instance?

A. Seldom without some leakage.

390 x-Q. They are used however, for that purpose with such high pressures for steam-boiler water-gauges? 6779

A. Yes, where a slight leakage would be a matter of no consequence, they are the usual arrangement.

391 x-Q. If the King lamp were used for lighting submarine work by divers and the like, what pressure would it be subjected to?

A. That depends on the depths.

392 x-Q. What is the extreme depth that divers are able to work at? 6780

A. They could work at depths up to probably 100 feet or more.

393 x-Q. What depth of water would be necessary to produce a pressure of 150 pounds such as steam water-gauges are subjected to?

A. In round numbers about 300 feet—a little more than 300.

6781 394 x-Q. Is it not a fact that the construction which you and Dr. Morton put upon the expression "suitably sealed" in the King patent would make it necessary to substitute for the copper wire *n* in the King patent a platinum wire?

A. Certainly that would be done in the sealing contemplated, in my opinion.

395 x-Q. And the glass barometer tube should be contracted in order to be readily sealed upon such a
6782 wire?

A. Naturally in the sealing operation the contraction of the glass tube would either be produced before the sealing or during the sealing, and it would be a natural procedure to produce a portion of it before the sealing operation. A good deal would depend upon the interior diameter or bore of the barometer tube in question. Barometer tubes have frequently been made wider at the top and narrower below, the bore below averaging in some cases a little over a sixteenth of an
6783 inch.

396 x-Q. Do you find it specifically stated in the King patent that the copper wire *n* is to be replaced by a platinum wire?

A. No, not specifically so stated, though the words "suitably sealed" appear to me to involve that idea.

397 x-Q. You have stated that you think the indications of the King patent are that it contemplates
6784 the use of quite small or thin carbons, such as would give a considerable resistance to the current. This you gather in part from the thinness of the platinum foil which is used by King. Look at Figure 1 of the King patent, which shows the platinum foil lamp, and observing the considerable width which the burner S has, please state what, in your opinion, would be the resistance of this burner?

A. I do not think that there is any data for arriving 6785
at the resistance, simply because the scale of the lamp is, as I understand it, not that of the drawing necessarily. The platinum is, however, to be exceedingly thin; in fact, it is to be obtained so thin that on holding it before a printed page the letters can be distinguished through it. This means, I should think, a thinness something like gold leaf, as gold leaf itself is transparent partly to light when held up in a single
thickness. The fact that the platinum is to be made, 6786
according to the King patent, by the ordinary process of the gold beater, shows that he contemplates a thinness comparable to that of gold leaf; but he describes a more accurate method, which is to roll it out between plates of copper and afterwards remove the copper plates. The thinness obtainable in this way is probably between the one two-hundred-thousandth and the one one-millionth of an inch in thickness. It has been stated that gold has been so reduced as to require
nearly a million sheets to make up an inch in thick- 6787
ness. I don't know whether platinum could be reduced to this extent, but it certainly could approximate gold, as it is an extremely easy metal to roll. The width of the platinum sheet shown in the drawing, if taken as indicating the actual dimensions, would be about half an inch and its length between the clamps two inches. The calculation of resistance might be based upon an assumed thickness with the dimensions just taken.

If the thickness assumed be taken even at the low- 6788
est limit that I have indicated above, say at one-two-hundred-thousandth of an inch, the resistance, when incandescent, will be about 22 ohms. This assumes that the specific resistance of platinum as regards copper is 5 and 6-10 in round numbers, and that this resistance is increased by rising incandescence in the proportion of one to eight, which, I think, is a fair proportion. I

6789 find, however, on referring to the King patent itself that the platinum is not only to be worked into these exceedingly thin sheets similar to gold leaf, but its width and length are also to be adjusted. This is expressed in the paragraph on the second page of the patent, as follows: "A strip is to be cut from one of these sheets of a width proportionate to a quantity of the current," which, with Grove cells, having platinum plates three inches long and two inches wide, is about
6790 one-fourth of an inch, and of a length proportionate to the intensity, which, of course, varies with the number of cells. This statement is very exact and complete as a statement of the steps which would be taken to adapt the burner to variations in the quantity of current to traverse it, and in the electro-motive force with which it is to be operated; and it means that the greater the electro-motive force, the longer will be the strip, and the smaller the current to be used in the burner the narrower will be the strip. If we halve the
6791 width of the strip and double its length, the resistance, when incandescent, would increase in the proportion of one to four. Thus, if the strip assumed above be halved in width so as to be one-fourth of an inch wide, its resistance would be doubled or become 44 ohms, and if its length were increased to double, its resistance would further increase twice and become 88 ohms. If, with the strip remaining only two inches long, the width were cut down to one-eighth of an inch in adapting it to the current used, its resistance when incandes-
6792 cent would be between 80 and 90 ohms.

397 a x-Q. Taking the first example, that of 22 ohms incandescent, what would be the resistance of this burner in ohms if measured cold?

A. The resistance, taking it as increasing eight times during incandescence on account of the property of metals to increase their resistance by heating, we

would divide 21 by 8 and would have a little less than 6793
3 ohms.

397 b x-Q. Is it not a fact that the leaf-form given the burner by King produces the maximum of radiating surface for a given resistance, rather than a minimum?

A. It makes, of course, a large radiating surface as compared with the amount of material used in the burner, or, in other words, gives to the burner as much radiating surface as can be obtained with a certain restricted amount of platinum. This is done, as I take 6794
it, for the simple reason that platinum does not have a considerable resistance until it is rollled into an exceedingly thin sheet, and also to avoid the use of extreme lengths of the sheet.

397 c x-Q. What form in cross-section of the platinum burner would give the minimum radiating surface, the cross-sectional area remaining the same as in the leaf?

A. A round wire of course. 6795

398 x-Q. With a vacuum such as proposed for the King carbon lamp, mercury vapor would be present, would it not?

A. Well, if the lamp were sealed off after the vapor was formed, the mercury vapor present would be about the same as in the operation of any mercury pump—and if the mercury were cold, or a little below 60 degrees Fahrenheit, the vapor would be practically inappreciable.
6796

399 x-Q. With regard to forming an incandescent conductor by reducing a piece of gas-retort carbon to size by saw and file, is this process used in any commercial incandescent lamps?

A. No, I think not.

400 x-Q. You think it a process which is calculated

6797 to be attended with success for commercial incandescent lighting?

A. It depends on the carbon and the delicacy of the work. I do not think it is a desirable process by any means for the producing of a carbon unless it be understood that the filing operation could be replaced by abrading or grinding operations similar to lapidary work, in which case I think a homogeneous slip of carbon might be reduced very considerably. No
6798 doubt the sawing and filing is a crude procedure in producing a carbon, but the material spoken of—hard carbon—has generally been cut in that way.

401 x-Q. That material, however—that is, gas-retort carbon, cut to form from a lump of the carbon, is not used for commercial incandescent lamps, is it?

A. No, I believe not.

402 x-Q. In the construction proposed by the King
6799 patent how would the deleterious gases which would be given off by the carbon and the surrounding parts be taken care of? Does the King patent make any provision for this?

A. No, the patent makes no provision for removing these gases; they would cause a fall in the mercury column if the mercury were present as in the first contemplated form.

403 x-Q. They would remain in the lamp-chamber
6800 whether the mercury was present or the lamp was detached from the mercury column as you and Dr. Morton think it may be?

A. They would, unless the evident expedient of re-inverting the mercury column after the heating of the carbon and restoring the lamp to its original vertical position before again running it had been resorted to. This expedient I may say, was well known in the restoration of barometers in which the Torricellian

vacuum had been rendered faulty by leakage. Of 6801
course if the lamp were sealed before this were done, the gases would remain in the sealed portion.

404 x-Q. Returning to the use of a frame with the submarine lamp of the King patent which you think would be necessary if the mercury cup were retained in order to hold the parts together, would not a weight be required with such a lamp to submerge it even if the lamp were detached from the mercury column? 6802

A. Not necessarily. The conducting wires themselves, if denser than water, might easily carry the lamp with them. They would naturally be made of copper and would sink readily.

405 x-Q. A weight, however, would be desirable to carry the lamp down without too great a slack of the wires?

A. It would depend very much as to how the divers used the lamp. If the lamp were used in currents of 6803
water a weight would be desirable, but if attached to or carried by the diving-bell or the diver's mantle, it would not be specially useful to add any weight outside of the control so obtained.

406 x-Q. Referring to the Sunbeam lamps which you have testified about, how many of those lamps have you seen in operation and where and when?

A. I saw in London quite a number; in fact, I was surprised to find so many in use in London last year. 6804
In many cases where otherwise arc lamps would be employed the Sunbeam lamps seemed to be used.

407 x-Q. Are they in use in this country to any extent?

A. I don't know that they are to any extent; in fact, I don't know of any specific instance in which they are regularly used.

6805 408 x-Q. When were these large, Sunbeam lamps first used abroad, if you know?

A. Within the past two or three years. I do not recollect the exact time of having seen them advertised for sale, but it may be as much as two or three years ago.

409 x-Q. Where did you get the one which you offered in evidence?

A. It was sent over by our European agents, I be-
6806 lieve, as an example of what was being introduced to a considerable extent in London and in other parts of Europe—chiefly England I believe.

410 x-Q. How many of these Sunbeam lamps did you import?

A. I don't know. Those that I saw were three, I think; whether any others were bought at the same time I am not aware. They were shown to me as specimens of what was being used.

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411 x-Q. Do you know how the one which was offered in evidence came to be broken?

A. No. I am not sure. My impression is that it was broken by accident and and that then it was farther broken for the purpose of getting at the carbon and ascertaining its diameter. I remember now that it was stated to me to take 16 amperes, by one of our men who said he had tried the lamp. It must have been broken after this either purposely or by accident. I
6808 do not know which.

412 x-Q. Can you produce a schedule of the lamps manufactured at the present time by your company showing the dimensions of the carbons and the resistance cold of the carbons, together with the candle-power, volts and amperes?

A. I here produce a schedule which I believe to be correct although I have had no chance to verify it.

The schedule referred to by the witness is offered in evidence by counsel for complainant, and the same is marked "Complainant's Exhibit, Schedule of Thomson-Houston Lamps." 6809

413 x-Q. What in general, if any, are the relations between your company and the Westinghouse Electric Company with respect to incandescent electric lamps? 6810

A. I am not altogether familiar with the business arrangements, but, as I understand it, the Thomson-Houston Company has a license from the Consolidated Electric Light Company under the lamp patents owned by that Company to make incandescent lamps for certain purposes, and the Consolidated Electric Light Company is, as I have been informed, under the control of the Westinghouse Company.

Cross-examination closed.

6811

Adjourned at 3.30 P. M. to Friday February 21st, 1890 at 11 A. M.

BOSTON, MASS., February 21, 1890.

Met pursuant to adjournment.

Counsel present as before.

Re-direct examination of witness Elihu Thomson, by Mr. Duncan. 6812

414 R-d. Q. Which is the more ductile of the two metals, platinum and gold?

A. The more ductile metal is platinum.

415 R-d. Q. If a carbon burner were to be made of the same dimensions as you have indicated for the platinum burner of the King lamp in your answer to x-Q. 397, what approximately would be its resistance?

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A. Assuming such a thing possible, the resistance would greatly depend upon the integrity of the carbon sheet throughout, that is, whether it were porous or non-porous. In fact, I cannot imagine it porous with a thickness so small. Its resistance would be, I think, a number of times that of the platinum sheet assumed, the number depending altogether on the specific resistance of the carbon compared.

6814 416 R-d. Q. It has been stated in this case by Dr. Barker that the relative specific resistances of carbon and platinum are about 250 to 1. Do you agree to this?

A. I understand the relation given to be the resistances compared cold, and not at incandescent temperature. The carbon would drop in resistance at incandescence approximately one-half, and the platinum increase approximately eight times, so that
6815 we would have to take one-sixteenth of the relation
given approximately. This would give a relation of 1 to 15. I am at a loss however, to accept the figures as exact for carbon generally. I have had indications of carbon produced by special treatment running much below that relation.

417 R-d. Q. Take incandescent lighting as it exists to-day, with all the improvements that have been made in the modes of generating and distributing the current, and of regulating the same, and the many hundreds of improvements that have been made in the
6816 lamp itself; how does this mode of lighting compare in economy, as a rule, with lighting by gas?

A. I have before stated that, in my opinion, the lighting by gas is the cheaper method as a rule. This is evidenced when the two come into competition on a large scale, it being generally found that the price of gas can be lowered below a point with which the in-

6817

candescent light could not easily compete, and this is, in fact, the case in spite of the condition of the gas manufacture in many cases employing old methods and making but little use of the by-products of the manufacture.

418 R-d. Q. Assuming Defendant's M-lamp to have the capacity of use as regards the extent of the territory in which it can be employed on a single plant
which, on your cross-examination, you have indicated 6818
to be possible; how far in your judgment, could such lamp be made the basis of commercial operations with the modes of distributing the electric current that were known to the art at the date of the Edison patent in suit?

A. The lamp, in my opinion, is of too low a resistance to be commercially used in any scheme of general distribution, even over limited areas. With distances from the generating apparatus of only a few hundred
feet, the loss in potential, unless very large conductors 6819
involving an enormous outlay for copper be employed, will be prohibitive.

419 R-d Q. In your answer to question 20, you referred to a statement made by Mr. Edison in his testimony in the McKeesport suit, to the effect that the first central-station incandescent lighting under his system was put in operation in the fall of 1882. What were the precise words used by Mr. Edison in making that statement? 6820

A. The words taken from the answer are, "By reason of the obstacles which are usually met with in the establishment of an entirely new art, the introduction of my apparatus proceeded slowly at first. The company did more or less business in the way of selling isolated plants for lighting single buildings, but it was not until the fall of 1882, that a complete central station was in operation."

6821 420 R-d Q. In your cross-examination at questions 141 and 182, Mr. Dyer indicates that when you expressed the opinion found in your answer 8 as to the unpractical character of the special lamp which is shown and described in the patent in suit, you assumed the maker of such lamp to follow the exact instructions of the patent without supplementing the same by the exercise of skill and good judgment. Please state how far in expressing that opinion you assumed that the instructions of the patent were, in fact, to be sup-
6822 plemented by skill and good judgment?

A. I, of course, assumed that the instructions of the patent were to be supplemented by the use of skill and good judgment without, however, militating against the objects set out in the patent, or without bringing into the lamp any conditions which were different from, or opposite to, those specially set down in the specification as to be attained in following out the specification.

6823 421 R-d Q. One of the main criticisms which in your direct-examination you made upon the lamps which is specially shown and described in the patent in suit, was the difficulty, within the limitations of the patent, of making a large number of lamps so uniform in resistance and illuminating power that they could be used in large numbers in multiple arc on a single circuit. On cross-examination (x-Q. 190 et seq.) you have been pressed to know whether good skill and judgment would not have dictated the use, supplemental of
6824 the processes specially mentioned in the patent, of some hydro-carbon treatment or some process of soaking the carbon burner in a carbonizable liquid and then re-carbonizing it, and thus in one of these ways securing the desired uniformity or standardizing. Please state whether either of these processes would be permissible under the conditions set forth in the patent in suit, and if not, why not?

A. I do not think they would be permissible under the processes of the patent in suit, simply because the object of the patent is to use in the lamp the products of carbonization having a high specific resistance. 6825
The treatment operation referred to distinctly worked to lower the specific resistance, and the treatment in hydro-carbons in particular very rapidly lowers the resistance of a carbonized material submitted to that treatment. Furthermore, the process of soaking in carbonizable material and subsequent recarbonization could not, in my opinion, be used to secure standard 6826
effects, or to make up for irregularities, as it is not susceptible of that kind of adjustment, while the treatment in hydro-carbons has been rendered susceptible to that kind of adjustment, by refinements introduced subsequently to the invention of the patent in suit.

422 R-d Q. You have been asked on cross-examination about the difficulty of making a helical, tar-putty burner, such as is contemplated by the Edison patent, by coiling the same on a mandrel composed of a 6827
closely-wound, copper-wire spiral; please state whether, in your opinion, it would be more difficult to make one of these burners with the use of such a mandrel than it would be if you were to employ a plain, cylindrical mandrel?

A. I think that in any case if the mandrel supports the coil during the carbonization, the effects of shrinkage would undoubtedly destroy the coil or spiral, and for the reasons I have pointed out, namely, that the extreme delicacy of the material and its small diameter 6828
relatively to its length, and the fact that the mandrel would expand while the carbon constantly underwent a shrinkage as the temperature increased, the carbonization process, so far as the attainment of solidity is concerned, being prior to that of a considerable shrinkage.

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423 R-d Q. In your cross-examination you have referred to the fact of the superiority of the arc light over the incandescent light in the matter of economy. To what is this superiority in economy due?

A. The superior economical production of light from the arc light over other means of artificial illumination, is due to the exceedingly high temperature existing at the ends of the carbons producing the arc. These ends are raised to the highest possible incandes-
6830 cence by the heat of vaporization of carbon, the limit, indeed, of the temperature being that which vaporizes the carbon itself. As the light-giving power of any body when heated increases at a rate much more rapid than the mere increase of temperature after becoming incandescent, it is evident that the attainment of an excessively high temperature means abundant light with little expenditure of energy.

6831 424 R-d. Q. The first paragraph in the statement of invention contained in the patent in suit says that "The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place;" what arrangement other than coiling would be adapted to secure the result thus set forth?

A. If the carbon were folded back and forth on itself so as to bring the portions closely adjacent, and thus
6832 limit the surface exposed for radiation, this would give the same effect as coiling in restricting the total effective radiating surface.

425 R-d Q. At the time when the Thomson-Houston Company took up the business of incandescent lighting, were there other companies besides the Edison Company that were engaged in the manufacture and sale of incandescent lamps?

6833

A. Yes, there were several companies. The United States Electric Lighting Company, the Brush-Swan Company, the Bernstein Company and the Consolidated Company, I believe.

426 R-d Q. How early, if you know, were any of these companies in the field and engaged in this business?

A. The United States Electric Lighting Company, I believe, were in the field in the year 1880. 6834

Re-cross examination by Mr. Dyer:

427 R-x Q. What is your opinion as to the possibility of producing a carbon burner having the dimensions assumed in the re-direct examination in R-d Q. 415, especially if it were to be made from gas retort carbon by the use of the saw and file?

A. I do not think that there is such a possibility.

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Examination closed. Counsel for both parties waive the signature of Prof. Thomson to this deposition.

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Complainant's Exhibit, Schedule of Thomson-Houston Lamps.

Feb'y, 1890. S. M. H., Ex'r.

LAMPS MADE BY THE THOMSON-HOUSTON ELECTRIC CO.

	Material.	C.P.	Volts.	Amp.	Cold Res.	[After Baking.] —Dimensions of Carbons.— Length. Inches.	Width. 1000ths of Inch.	Thick or Diam. 1000ths of Inch.	Diam. Plat. Wires. Inches.
	Bamboo....	10	52	.65	162	5.08		4.92	.016
	"	16	"	1.04	98	5.77		6.93	"
	"	20	"	1.30	78	6.25		7.99	"
6838	"	25	"	1.63	61	7.07		8.83	"
	"	32	"	2.08	49	6.64		12.04	.018
	"	50	"	3.25	31	11.47	24.09	11.32	.020
	"	64	"	4.16	25	7.14	25.53	11.61	.022
	"	75	"	4.88	22.8	6.17	33.15	10.45	.024
	"	100	"	6.50	17.1	7.81	32.75	12.52	.028
	"	125	"	8.13	13.6	7.71	40.59	17.00	.030
	"	150	"	9.75					.032
	"	10	75	.44	339	5.24		4.21	.016
	"	16	"	.70	200	5.89		5.94	"
	"	20	"	.88	155	6.37		6.87	"
	"	25	"	1.10	145	7.28		7.51	"
6839	"	32	"	1.41	95	6.15		11.31	.018
	"	50	"	2.20	62	6.69	22.86	7.02	.020
	"	64	"	2.82	51	7.50		22.74	.020
	"	75	"	3.30		8.60		11.43	.020
	"	100	"	4.40	38	7.43	31.91	9.71	.022
	"	125	"	5.50	26				.024
	"	150	"	6.60	22	10.11	38.17	15.37	.028
	"	10	110	.36	599	6.14		4.15	.016
	"	16	"	.58	335	7.33		6.38	"
	"	20	"	.73	285	7.20		7.07	"
	"	25	"	.91	224	7.42		6.58	"
	"	32	"	1.17	174	7.89	13.87	5.77	"
	"	50	"	1.82	106	7.56	23.58	7.76	.020
6840	"	64	"	2.33	98	8.51	24.82	9.05	"
	"	75	"	2.73	81	9.56	22.61	9.83	"
	"	100	"	3.64	66	9.58	30.34	11.40	.022
	"	125	"	4.55					"
	"	150	"	5.46	44	9.74	52.45	11.31	.024
	"	20		3.5	12.1	1.38	24.88	10.80	.020
	"	25		"	15.1	3.03	"	"	"
	"	30		"	18.1	3.72	"	"	"
	"	50		"	29.0	6.06	"	"	"
	"	20		6.5	3.5	1.45	45.08	22.32	.028

6841

LAMPS MADE BY THE THOMSON-HOUSTON ELECTRIC CO.

Material.	C.P.	Volts.	Amp.	Cold Res.	[After Baking.] —Dimensions of Carbons.— Length. Inches.	Width. 1000ths of Inch.	Thick or Diam. 1000ths of Inch.	Diam. Plat. Wires. Inches.	
Bamboo....	25		6.5	4.3	1.89	45.08	22.32	.028	
"	32		"	5.2	2.27	"	"	"	
"	65		"	9.2	4.01	"	"	"	
"	125		"	19.0	8.21	"	"	"	
"	20		9.9	1.5	1.38	39.47	16.79	.032	
"	25		"	1.9	1.72	"	"	"	6842
"	32		"	2.4	2.21	"	"	"	
"	65		"	4.6	3.95	"	"	"	
"	125		"	9.4	8.27	"	"	.	
"	25		5.5	5.9	5.89	32.90	11.51	.024	
"	30		"	7.1	3.01	"	"	"	
"	40		"	9.4	4.01	"	"	"	
"	50		"	11.8	5.02	"	"	"	
Silk........	16	52	1.04	1.04	6.18		6.22	.016	
"	32	"	2.12	49	6.51		12.18	.018	
"	32	"	2.12	49	6.55		12.46	"	
"	50	"	3.25	32	4.89	22.05	14.82	.020	
"	50	"	3.25	32	4.90	23.23	16.82	"	6843
"	50	"	3.25	32	5.86		21.33	"	
"	16	104	1.53	392	6.71		5.28	.016	
"	25	"	.86	242	6.85	7.16	6.49	"	
"	16	110	1.58	335	6.89		6.79	.016	
"	50	"	2.20	100	7.95	15.51	13.40	.020	
"	40		2.8	35.6	6.78	15.43	13.64	.020	

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6845

UNITED STATES CIRCUIT COURT,

FOR THE SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT COMPANY, Complainant,	In Equity No. 3445.
against	
6846 THE UNITED STATES ELECTRIC LIGHTING COMPANY, Defendant.	On Letters Patent No. 223,898.

BOSTON, MASS., February 21, 1890.

Met pursuant to agreement.

Present—C. A. SEWARD and R. N. DYER, of counsel for complainant; S. A. DUNCAN and L. E. CURTIS, of counsel for defendant.

6847

CHARLES R. CROSS, being called as a witness for the defendant, and being duly sworn, in answer to interrogatories by S. A. DUNCAN, defendant's counsel, testifies as follows:

1 Q. What is your name, age, residence and occupation?

A. Charles R. Cross; 41 years of age; I live in Boston, Mass., and am Thayer Professor of Physics in the
6848 Massachusetts Institute of Technology.

2 Q. What knowledge have you of the science of electricity, and of the various applications of electricity to the useful arts, and particularly the art of electric lighting?

A. During the past nineteen years, in the position which I have occupied at the Massachusetts Institute

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of Technology, I have constantly been required to give extended instruction in the study of electricity, both theoretical and applied. I have, during a large portion of that time, given special courses of lectures relating to applied electricity, and particularly to the theory and practice of electric lighting, both to my own classes and in public.

I am director of the Rogers Laboratory of Physics in the Institute of Technology, and have under my
care the large collection of apparatus for electrical 6850
measurements and testing belonging to that laboratory, and have the direction and superintendence of the work of instruction and research which is constantly carried on in that laboratory.

About seven years ago, at my suggestion, a course in electrical engineering, the first to be established in this country, was instituted in the Institute of Technology, and since that time by far the greater part of my time has been occupied in the development of that course.
In this connection, I have immediately under my care 6851
the instruction of students, both in the lecture room and laboratory, in the study of technical electricity, and a very great portion of that instruction is devoted to different branches of electric lighting, which I am accustomed to treat with minuteness. I have personally, and in connection with my advanced students, made numerous researches in electricity, and especially in its application to the telephone and to electric lighting, and have published a number of papers thereon.

I have several times served upon juries called to de- 6852
cide upon the relative merits of electric lamps, dynamo machines and other devices used in electric lighting, and have become familiar with the various systems of electric lighting which have been proposed or used.

I have frequently, during the past twelve years, given testimony in the United States courts regarding electrical inventions, and have testified in almost all of the principal suits relating to the electric speaking-tel-

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ephone; and also in numerous suits relating to electric lamps and electric lighting. I have kept myself informed as to the development of the incandescent electric lamp and its employment for electric illumination, and am familiar with the history of this branch of the art. I am acquainted with the various devices which have been proposed or used for this purpose.

3 Q. State whether you have examined and are fami-
6854 liar with Letters Patent of the United States No. 223,898, granted to Thomas A. Edison, January 27, 1880, being the patent in suit in this cause?

A. I have read the patent referred to in the question, and am familiar with it.

4 Q. This patent states that the object of the invention to which it relates is to produce "electric lamps giving light by incandescence." What is "an electric lamp giving light by incandescence," or, as it is
6855 generally called, an "incandescent lamp;" and wherein does such lamp differ from an "arc lamp?"

A. In an *incandescent* lamp, light is produced by the passage of a current of electricity through a resisting conductor. That conductor, by reason of its resistance to the flow of the current, becomes highly heated, and is thus brought to a state of incandescence.

In the electric *arc*, on the other hand, an electrical discharge is forced to pass through an air gap separating two conductors, usually of carbon, and this cur-
6856 rent, chiefly by actions produced at the terminal surfaces of the solid conductors, though partly by its action in overcoming the resistance of the air space, produces a great development of light.

5 Q. The Edison patent in suit, in setting forth the prior state of the art, speaks only of incandescent lamps in which "the atmospheric air has been replaced by gases that do not combine chemically with the car-

6857

bon"—meaning the carbon which constitutes the burner of the lamp; and, apparently, the patent seeks to explain the invention to which it relates by emphasizing the fact that the patentee proposes to use "almost a perfect vacuum," and thus contrasting the patented invention with this assumed prior state of the art.

Please state whether, in the particular referred to, the patent correctly represents the prior state of the art?

A. In my opinion it does not. There are various instances, long prior to the date of the patent referred
to, in which incandescent lamps have been described, 6858
having as perfect a vacuum as was obtainable; such vacuum, as it seems to me, meeting fully the requirement of the Edison patent contained in the words "almost a perfect vacuum."

One of the very earliest incandescent lamps ever described, was that set forth in British patent No. 10,919, granted to King in the year 1845. In one form of this lamp a "small pencil" or "thin plate" of carbon is employed as the incandescing conductor; and
this conductor is enclosed in a Torricellian vacuum, in 6859
order to avoid the destruction of the carbon by its combination with the oxygen of the air. According to the statements of the patentee, he uses the Torricellian vacuum in order to accomplish this end most completely. He says, regarding the exclusion of air and moisture from the interior of the lamp:

> "To accomplish this in the most perfect
> " manner it [the carbon] should be enclosed
> " in a Torricellian vacuum."

6860

The Torricellian vacuum, when properly formed in accordance with the processes in common use in the construction of barometers at the date of the King patent, was the most perfect vacuum known, and, in my opinion, was quite as perfect as the vacuum which is employed in the incandescent lamps of to-day.

6861 The Roberts' British Patent, No. 14,198, of 1852, is another instance of a lamp within which the incandescing conductor is placed in a high vacuum. This incandescing conductor is a thin piece of carbon, and in one form of the lamp as figured and described, the conductor is enclosed within a glass globe or bulb greatly resembling in form the globe of the modern incandescent lamp. The Roberts' patent directs that the carbon conductor employed shall be

6862 "enclosed in a vacuum or space not contain-
"ing any oxygen or other matter which can
"cause the combustion or destruction of it
"when brought into an incandescent state by
"the action of the current of electricity."

The patent further says, regarding the exhaustion of the globe, that "as perfect a vacuum as can conveniently be made" is to be obtained; and, again, the
6863 patent says, regarding the finished lamp, that "no combustion will ensue if the vacuum be perfect."

There are various other incandescent lamps which have been described prior to the date of the Edison patent under consideration, whose conductors were inclosed in transparent receivers within which a vacuum was created.

I am, therefore, of the opinion that the Edison patent misrepresents the prior state of the art, in regard to the matter inquired of in the question.

6864 5½ Q. How do the vacuums contemplated by King and Roberts, in the British patents referred to in your last answer, compare with that contemplated by the Edison patent in suit?

A. The Edison patent says that "there must be al-"most a perfect vacuum to render the carbon stable, "especially when such carbon is small in mass and high "in electrical resistance." Again, the Edison patent speaks of a vacuum of "one millionth of an atmos-

phere;" and, again, the patent says that the lamp is sealed off from the pump when "a high vacuum" is secured; and Claim 2 contains the condition that "the air is exhausted" from the globe. 6865

As I understand the statements in the British patents referred to, they direct the use of a vacuum of the same character, as to degree, as that which the Edison patent in suit requires.

The King patent, as I explained in my last answer, contemplates the use of the *most perfect vacuum obtainable*. Referring to the removal of air and moisture from the receiver of the lamp, the patent says: "To accomplish this in the most perfect manner, it should be enclosed in a Torricellian vacuum." 6866

The Roberts patent of 1852 also contemplates the use of as perfect a vacuum as is obtainable. It not only requires that the carbon conductor be "enclosed in a vacuum," but it distinctly indicates the character of the vacuum to be used, by the statement that when the thin carbon conductor is rendered incandescent, 6867 "no combustion will ensue if the vacuum be perfect."

It seems to me perfectly clear from these expressions, that the inventors named intended to use as perfect vacua as were obtainable, and that, at the dates of their respective patents, the vacuum which would have been used, if their directions were consistently followed, would have been "almost a perfect vacuum."

6 Q. The Edison patent, again, in setting forth the prior state of the art as regards the construction of the 6868 receiver of the lamp, makes note only of those lamps in which "the vessel holding the burner has been composed of glass cemented to a metallic base;" and apparently it seeks to explain the patented invention by emphasizing the fact that the patentee proposes to use a receiver made "entirely of glass," and thus contrasting the patented invention with this assumed prior state of the art.

6869 Please say whether in the particular now referred to, the patent correctly represents the prior state of the art?

A. It does not. Electric lamps in which no metallic base was used had been described prior to the date of the patent in suit. Thus, in United States patent No. 205,144, dated June 18, 1878, to Messrs. Sawyer and Man, is described an incandescent electric lamp, the receiver of which is closed at its base by a glass plate, or a glass stopper, through which pass the leading-in
6870 wires which convey the current to the carbon conductor. A second lamp of the same character is described in United States Patent No. 210,809, granted to the same patentees, December 10, 1878.

Also in British patent to Lane-Fox No. 4626, of 1878, I find a description of an incandescent lamp in which the burner is enclosed in a receiver or globe made entirely of glass. The glass neck of the receiver is fused about the platinum leading-in wires so as to make a perfect seal. The patentee states that
6871 with this lamp the receiver may either contain a vacuum or some inert gas.

I also find a similar lamp described in the preceding British patents of the same patentee, No. 3988 and No. 4043 of 1878, which are referred to in this patent No. 4626.

Also the alternative form of the King lamp set forth in British Patent No. 10,919 of 1845, would consist of a closed glass tube containing the burner, and with the platinum leading-in wires sealed into this tube by
6872 fusion. I refer to the particular form of his lamp which King proposed to use for submarine lighting and like purposes, which would have been constructed by drawing out and sealing the upper end of the barometer tube containing his burner. This, of course, would have given a lamp, the receiver of which would have been composed entirely of glass and into which the leading-in wires were sealed by fusion.

Still further, there were at the date of the Edison 6873
patent in suit, and had been for many years prior to that date, electric lamps manufactured and sold in which there existed a very high vacuum, and the receiver of which was not closed by any kind of metallic base or stopper, but was made entirely of glass. I refer to the well known Geissler-tube lamps which had been made and sold for various purposes where electric illumination was desirable, as for fishing lamps, miner's lamps, and surgical lamps for examining the 6874
cavities of the human body, as the throat. In these lamps the electricity is forced to overcome the high resistance of a thin thread of rarefied gas, which gas is made incandescent in consequence of its high resistance, which the electricity has to overcome in its passage through it. These lamps were universally made of glass tubes or bulbs of different forms into which were sealed the platinum electrodes or leading-in wires by which the electricity entered and left the lamp.

There existed, also, a well known form of Crooke's 6875
radiometer which contained a fine platinum wire sealed into the glass bulb of the instrument at the points of entrance and emergence of the wire. In this instrument a current of electricity was passed through the plantinum wire which was thus heated to incandescence. The globe or bulb was made entirely of glass and was very highly exhausted.

It seems to me evident from these various instances, that the quotation from the Edison patent contained in the question, conveys a false impression as to the 6876
prior state of the art.

7 Q. The Edison patent, again, in setting forth the prior state of the art as regards the total resistance of the older incandescent lamps, assumes the existence of lamps having a total resistance of from one to four ohms only; and apparently does this for the pur-

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pose of contrasting therewith, in this feature of total resistance, the burners of the patent.

Please say whether, in the particular now referred to, the patent correctly represents the prior state of the art?

A. I do not think that the patent does correctly represent the prior state of the art in this respect. Undoubtedly some of the various incandescent lamps which had been previously devised employed carbons whose resistance, as the lamps were actually con-
6878 structed, did not exceed the limit stated by Mr. Edison; but I do not think that it is at all true that this fully represents the actual state of the art at the date of the Edison patent.

I am confirmed in this opinion by the statements which I find in various patents and publications prior to the date of the Edison patent in suit. Thus, in British patent to Lane-Fox, No. 3988 of 1878, I find described an electric lamp employing preferably an alloy of platinum and iridium in a very thin strip or
6879 wire. The patentee states that the resistance of the lamp and the extent of its luminous surface depend upon the desired illuminating power and upon the electro-motive force with which it is to be used. He describes a parallel or multiple-arc system of distribution in which he proposes to use the lamps, and says that the electro-motive force of the mains "should be kept as nearly as possible constant at, say, 100 volts." The patentee further explains his particular object in using lamps of high resistance, run at the high pres-
6880 sure referred to, as follows:

"In order that the electric force may be "conveyed at a high tension, that is, having "a high electro-motive force, so that there "may not be any very great loss from the "resistance of the conducting mains or con-

6881

"ductors, I make the lamps, when I use an "alloy of platinum and iridium, of lengths of "fine wires so that I may get a high resistance "without having a large extent of luminous "surface."

This, as I understand, is precisely the reason given in the patent in suit for making the burner of high resistance.

Also in British patent to Lane-Fox No. 4043 of 6882
1878, I find described an electric lamp of high resistance, in which the burner is made "of asbestos or similar non-conducting material saturated or impregnated with some refractory conducting material such as carbon or iridium."

Also in British patent to Lane-Fox No. 1122 of 1879, provisional specification, I find a description of a high-resistance lamp in which the incandescing material is of carbon. The patentee states that the burner employed by him should have a resistance of 6883
about 300 ohms, and that in order to obtain such a high resistance he combines certain non-conducting materials with the carbon used by him. Describing the construction of one form of this burner, he says:

"Sometimes, also, I produce on the surface "a very hard film of carbon, and this I effect "after the bridge has been made, by treating "it at a high temperature with a hydro-car- "bon, for example, by raising it to an incan- 6884
"descent state by sending a current through "it while immersed in a dense hydro-carbon."

The patentee also states that in order to produce a light approximately equal to that of an ordinary gas-jet with such a burner as he describes, having a resistance of about 300 ohms, an electro-motive force of 140 volts is employed.

6885 In addition to the above, I find an incandescent lamp of very high resistance described in French letters patent to Thomas Alva Edison No. 139,110, dated May 28, 1879, and Italian letters patent also granted to Mr. Edison, dated June 23, 1879. These two patents, I believe, are substantially identical with each other; and in each of them there is patented the same lamp which is shown and described in the United States patent No. 227,229, granted to Mr. Edison May 4th, 1880,
6886 upon an application filed April 21, 1879. Therefore, for greater convenience I will refer to the specification of the United States patent.

In Mr. Edison's United States patent referred to, I find described a high resistance lamp made of platinum or iridium wire, whose resistance when incandescent is about 750 ohms. The patentee states that, on account of the high resistance, all the lamps to be used in a circuit may be placed in multiple-arc, thereby securing the advantages of such a system of distribution, while
6887 at the same time the total resistance of the whole number of lamps employed is not reduced to so small an amount as to necessitate the employment of an extremely large current. The patentee is thus enabled to make use of main conductors of moderate dimensions.

Besides the patents above referred to, there are descriptions of incandescent lamps in other publications and patents which, in my judgment, are such as naturally would lead a person seeking to construct the described lamps, under certain circumstances, to employ
6888 resistances much greater than those mentioned as old in the Edison patent in suit.

For example, in the British patent of King, of 1845, it is directed that the incandescing conductor shall be made "exceedingly thin;" and, in the case of platinum, directions are given whereby to produce a most wonderfully thin film of that metal with a view to employing it in the lamp. It is obvious that the sole idea in

using this exceedingly thin burner was to give to the 6889
lamp a suitably high resistance.

With regard to *carbon*, the directions of the King patent are also explicit in the same direction. The patentee says that the carbon which he proposes to use may be worked into the form of either "small pencils or thin plates." I infer from this statement, especially when read in connection with the preceding directions as to the size of the metallic incandescing conductors when such are used, that the patentee intended to 6890
make use of pencils or plates of carbon as thin as they could practically be made consistently with stability.

Now, whatever may have been the maximum resistance consistent with durability that King himself could have obtained in 1845, working with the appliances and by the methods then known to him, it seems to me perfectly clear that, at a somewhat later date, and long prior to the date of the Edison patent, one skilled in the art, if called upon to make an incandescent lamp of the King type, would have understood dis- 6891
tinctly, and without the slightest exercise of invention, that, in order to obtain the best results, he should use a carbon conductor as thin and fine as he was able to secure at the time at which he was working. I assume, of course, that the person in question was desirous of using a lamp under conditions of circuit such as would call for a high total resistance of the lamp rather than for a low resistance. Of course there are conditions of circuit which would make the use of lamps of comparatively low resistance desirable rather 6892
than the reverse; as, for instance, where a large number of the lamps are to be used in series. Long prior to the date of the the application for the Edison patent in suit, processes had been invented and had become well known to those skilled in the art, whereby carbon conductors could be made having a much higher total resistance than the values mentioned as old in the Edison patent. A skilled artisan at the date of

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Mr. Edison's application, and in fact long prior thereto, if called upon to construct an incandescent lamp with a carbon incandescing conductor and suitable for operating under conditions of circuit requiring for economical working a resistance higher than that mentioned in the Edison patent as old, would have been bound to employ burners constructed of carbon made under some of the various improved processes which were well known and in public use at the time.

6894 8 Q. The Edison patent in suit also represents, in relation to the prior state of the art, that, because of the low total resistance of the carbon burners used in former lamps, the leading-in wires were necessarily so large that a glass globe could not be kept tight where the wires pass in. Please say whether the patent correctly represents the prior state of the art in this particular?

A. The patent certainly fails to correctly indicate the prior state of the art in this respect.

6895 It is perfectly possible to seal permanently into a highly exhausted glass reservoir leading-in wires of platinum of sufficiently large dimensions to readily convey the current necessary to bring to incandescence a carbon conductor whose resistance is as low as the values (1 to 4 ohms) mentioned in the Edison patent under consideration.

Indeed, lamps of this low resistance and furnished with platinum leading-in wires are in large commercial use to-day. As examples of these, I will cite the Bern-
6896 stein lamp whose resistance is less than one ohm; the Heisler lamp, whose resistance is about the same; some of the Thomson-Houston series lamps, having a resistance of about $\frac{3}{4}$ of an ohm; the various types of lamps made and sold by the Edison companies under the name of "Municipal" lamps, whose resistances vary from four to ten ohms.

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Moreover, the ability thus to seal permanently into glass, platinum wires of such dimensions as I am considering, is by no means novel. It had been well known and in frequent practice long prior to the date of the Edison patent in suit. For example, Geissler-tubes were made, the platinum leading-in wires of which were abundantly large to carry such a current as would be required for an incandescent lamp having a resistance as low as that mentioned in the Edison patent.

For these reasons it seems to me that the Edison patent is misleading as to the prior state of the art, in 6898
the particular named in the question.

9 Q. The Edison patent in suit, in setting forth the prior state of the art of incandescent lighting, alleges that "in general the attempts of previous persons have been to reduce the resistance of the carbon rod used as the burner." What do you understand to be the meaning of this statement?

A. I understand this statement to mean that it had been the general practice among constructors of incan- 6899
descent lamps, prior to Mr. Edison, to endeavor to lower the *specific* resistance of the carbon conductors used by them in their incandescent lamps.

Thus interpreted, the statement seems to me to be a correct expression of the state of the art; at any rate, down to a date not long prior to that of the Edison patent in suit. Constructors of incandescent lamps seem in most cases to have employed carbon of the same character as that used in arc lighting; and as to such carbons it is a well known fact that strong endeav- 6900
ors had been made to reduce the specific resistance to the lowest practicable limit, and the general use of such carbons in incandescent lamps led, of course, to a similar lowering of the specific resistance of the carbon utilized in them.

That the statement of the patent, referred to in the question, relates to *specific* resistance, and not to

6901 the *absolute* or *total* resistance of the lamp, it seems to me, must be assumed, further, from the fact that any other supposition makes the statement directly contradictory to well known facts. Thus for example, the directions in the King British patent and the Roberts British patent, already referred, to distinctly indicate that the actual *total* resistance of the carbon conductor should be increased by the use of *thin* plates or *small* pencils of carbon. So, also, in the United States pat-
6902 ent to Farmer No. 213,643, of March 25, 1879 (granted several months before the application for the patent in suit) it is provided that the carbon burner be made of "a small pencil or thin bar of carbon"—spoken of in another place in the patent as a "thin pencil or bar of carbon," and in another place as a "small, thin bar of carbon"; which plainly indicates that Farmer intelligently intended to secure the high resistance due to smallness of cross-section.

6903 There have, undoubtedly, been, subsequent to the dates of the King and the Roberts patent, incandescent carbon lamps of lower total resistance than would have been produced by one following out the direction "of those patents. Such lamps have been made both prior to the date of the Edison patent and subsequent to it, whenever the conditions under which they were to be used made such a construction desirable; but if one were to read the statement quoted from the Edison patent in suit as indicating that the general endeavor of inventors prior to Mr. Edison had been to reduce
6904 the total resistance of the carbon of the incandescent lamp, he would reach a conclusion quite erroneous and entirely at variance with well-known facts: but reading the quoted statement as indicating, that, prior to the date of Mr. Edison's patent, makers of incandescent lamps had generally attempted to reduce the *specific* resistance of the carbons used, rather than to raise it, the statement is entirely correct. Indeed I under-

stand that Messrs. Sawyer and Man, who were engag- 6905
ed in work of this nature in New York City in 1878, in that year devised and employed a process of treating a carbon conductor by the use of hydro-carbon vapor, which process largely diminished the specific resistance of such conductor.

From the notoriety which had been given to the work of Sawyer and Man prior to Mr. Edison's application for the patent in suit, it would seem probable that Edison had in mind these very lamps of Sawyer and 6906
Man which used the carbons of reduced specific resistance.

So, also, in Fontaine's "Eclairage à l'Electricité," published at Paris in 1877, and of which a translation by Paget Higgs was published in 1878, at London and New York, by F. & N. Spon, I find in chapter 3, pages 47 to 64, Paris edition (pages 38 to 52 English edition), a description of various processes of manufacturing electric-light carbons; from which it appears that the specific resistance of such carbons was reduced in the 6907
process of manufacture, by soaking them, after the first carbonization, in syrups or other liquids rich in carbon and recarbonizing them. The effect of this was to fill up the pores of the structure as left by the first carbonization with particles of the dissociated carbon from the carbonaceous syrup or liquid used in the second carbonization, and thus make the finished product denser in structure and consequently of lower specific resistance.

This mode of preparing carbon for use in electric 6908
lighting is more particularly referred to by Mr. Edison in his British patent No. 3765 granted to his agent Brewer, under date of September 16, 1880. In this patent it is stated:

> "As is now generally known, said Edison
> " prefers to use in his system of electric light-
> " ing an electric lamp consisting of an incan

6909 "descing conductor sealed hermetically in a "glass enclosing globe.

"In manufacturing carbons for such "and for all classes of electric lamps, the "practice, so far as known, has been to make "them of as low resistance as possible, a por- "ous carbon having been used which was "dipped or soaked in some carbonizable "liquid until its pores were filled and then
6910 "subjected to carbonization, which process "was repeated until the pores of the original "carbon were filled with carbon.

"By this process the resistance of the car- "bon is lessened, while its liability to disinte- "gration under high heat is increased. Such "carbons are unfit for use in electric lamps "giving light by incandescence.

"For such lamps said Edison has discovered "that the incandescing material should have
6911 "the highest possible resistance in a very "small bulk, and be capable of resisting the "disintegrating effects of very high heats and "the absence of atmospheric pressure, and "further that carbons which are purely struc- "tural in character alone possess these quali- "ties. By purely structural is meant a car- "bon wherein the natural structure, cellular or "otherwise, of the original material is pre- "served unaltered, that is, not modified by
6912 "any treatment which tends to fill up the "cells or pores with unstructural carbon, or "to increase its density, or to alter its resis- "tance."

Defendant's Counsel offers in evidence Chapter 3, pages 38 to 52, inclusive, of "Fontaine's Electric Lighting," translated by Paget Higgs, published by F. & N. Spon, in London

6913 and New York in 1878, the same being marked, "Defendant's Exhibit, Extract from Fontaine's Electric Lighting."

Complainant's Counsel admits that the said publication was published in 1878, as set forth, and is a correct translation of the French book referred to, and that the French Edition was published in Paris in 1877.

10 Q. The Edison patent in suit, after setting forth 6914 its assumed construction of the prior existing incandescent lamps, says, among other things, as follows:

"The disadvantages of following this prac- "tice are, that a lamp having but one to four "ohms resistance cannot be worked in great "numbers in multiple arc without the employ- "ment of main conductors of enormous di- "mentions."

What do you understand to be the meaning of the ex- 6915 pression "great numbers" in the paragraph quoted?

A. I have always understood that the object which Edison had in view was to effect "the practical subdivision of the electric light." This, in fact, is distinctly stated in the patent to be the object. This statement, when taken in connection with that which is quoted in the question, has led me to believe that Edison's object was to subdivide the electric light to substantially the same extent as gas light is subdivided; that is, by dis- 6916 tributing the illuminant (in the one case gas, and in the other electricity) from a common centre over wide districts, and thus to produce light in required quantities at any desired point throughout the district. This, I think, is what the word "practical," as used by the patent, imports. This is his real object in arranging the lamps in multiple-arc, since this arrangement enables one to put a vastly larger number of lamps in a single circuit than would be possible if the lamps

6917 were made to be run in series, or would be possible with
arc lamps; and it also makes all the lamps of the sys-
tem independent of each other, as is the case with gas
burners.

In the distribution of gas, as is well known, many
thousands of burners are supplied from a single main.
So, also, in the central-station system of incandescent
lighting, many thousands of incandescent lamps, when
arranged in multiple, can be and practically are sup-
6918 plied over a single circuit. I think, therefore, that, if
the lamp were so constructed that it could be used for
central-station work in the same numbers as gas bur-
ners supplied from a single source are used, such num-
ber might be properly regarded as a "large" number;
but if the lamp were so constructed that only a few
hundred could be used on a single circuit in central-
station lighting, I should not regard this as a "large
number" within the meaning of the patent.

This view finds confirmation in the statements made
6919 by Mr. Edison himself in his testimony in the suit of
The Consolidated Electric Light Co. vs. The McKees-
port Electric Light Co. In answer to Question 485 in
that case, after referring to the introduction of the arc
system and the work of previous inventors in connec-
tion with incandescent lamps, he says, at bottom of
page 285 of Defendant's printed record:

> "The problem that I undertook to solve
> 6920 "was, stated generally, the production of the
> "multifarious apparatus, methods and devices,
> "each adapted for use with every other, and
> "all forming a comprehensive system where-
> "by electricity, properly controlled and direc-
> "ted, could be distributed over large areas
> "through the streets of a city, and supplied
> "to houses in which it would feed incandes-
> "cent electric lamps of moderate candle pow-
> "er, which would be entirely under the con-

> "trol of the householder, the whole to be on 6921
> "the same scale as the present system of gas
> "distribution and affording the same charac-
> "ter of convenience to the users.
>
> "The first thing necessary to be done was
> "to adopt a fundamentally correct system of
> "distributing the electric current and then to
> "devise a lamp which could be worked prac-
> "tically on such a system—that would be
> "practical and satisfactory both in a commer-
> "cial and scientific sense. The essentials o 6922
> "a comprehensive system of electric illumina-
> "tion, similar to the general plan of illumina-
> "tion by gas, were a net-work of conductors
> "all connected together, so that in a city area
> "the lights could be fed with electricity from
> "several directions, thus eliminating the dis-
> "turbances to any particular section.
>
> "Second. To devise an electric lamp which
> "would give about the same amount of light
> "as the gas jet, which custom had proved was 6923
> "a suitable and useful unit, and which should
> "possess the qualities necessitated by small
> "investment, in the copper conductors. It
> "was also necessary that each lamp should
> "be independent of every other lamp, al-
> "though on the same circuit. That the light
> "should be produced sufficiently economi-
> "cally to commercially compete with gas.
> "That the lamp should be durable, and capa- 6924
> "ble of being handled by the public, and
> "cheap to manufacture, and one that would
> "remain incandescent and stable a great
> "length of time."

11 Q. What indication do you find in the Edison patent in suit as to the degree of the vacuum which Mr. Edison considered essential to the lamp to which the patent refers?

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A. The statement regarding this which the patent makes is that "there must be almost a perfect vacuum "to render the carbon stable, especially when such car-"bon is small in mass and high in electrical resistance." The only statement which indicates numerically or quantitatively what the actual degree of this vacuum is to be, is the following:"

> "I have discovered that even a cotton
> 6926 "thread properly carbonized and placed in a "sealed glass bulb exhausted to one-millionth "of an atmosphere offers from one to five "hundred ohms resistance to the passage of "the current, and that it is absolutely stable "at very high temperatures."

There is no intimation anywhere within the patent that such carbonized material as is referred to in this quotation could possibly be used except in a vacuum
6927 of substantially that degree of perfection. Neither do I find in the patent any intimation that with a lower degree of exhaustion it would be possible to use any form of carbonized material in a practical incandescent lamp.

12 Q. The second claim of the Edison patent requires that the air be exhausted from the glass receiver of the lamp. So far as this condition of the claim finds explanation in the specification, what do you understand the words to mean?

6928 A. So far as the specification leads to any definite interpretation of these words regarding the degree of exhaustion, its import must be found in the statements to which I referred in my last preceding answer. So far as these statements indicate the amount of the exhaustion referred to in claim 2, they go to show that the vacuum which the inventor had in mind was something of the order which is indicated by the numerical value "one-millionth of an atmosphere."

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13 Q. Dr. Barker, in explaining claim 1 of the Edison patent in suit, has stated in substance (in answer to question 5) that the term "carbon of high resistance" in said claim indicates that the burner of the claim is to be of carbon which has a high *specific* resistance as compared with the varieties of carbon in use for arc lighting at the date of the patent.

What is your view in regard to this, and how far do you agree with Dr. Barker?

A. In my opinion the high resistance referred to in 6930
the first claim is high *specific* resistance, rather than high *total* resistance of the burner. In this I agree with the statements made by Dr. Barker in his answer referred to in the question.

I am confirmed in this opinion by the statement made in the specification regarding the work of previous persons, which statement I have already discussed in my answer to question 9. In that statement the patentee says that the "attempts of previous persons have been to reduce the resistance of the carbon rod," 6931
which is correct as regards *specific* resistance, but grossly incorrect so far as the *total* resistance of the burner is concerned.

I find further confirmation of my view in a second statement which I find in the specification. The patentee, referring to the mode of procedure in various particulars employed by previous inventors, and among these to the reduction of the resistance of the burners used by them, says: "I have reversed this practice." These words, I understand to be intended to contrast 6932
the invention of the patent with the former inventions referred to, in the matter of specific resistance as well as in other particulars, and they naturally imply the production of higher specific resistance in the burners of the patent in suit than that employed in the previous burners.

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Moreover, the actual total resistance mentioned in the patent, immediately after the passage quoted, as attainable with cotton threads, namely, 2,000 ohms, would in my opinion be entirely impracticable to obtain, unless the specific resistance were left as high as possible, and not by any process brought down to the resistance that characterized the old carbons.

I understand that the specific resistance, in order to be high within the meaning of this claim, must be notably higher than that of the previous carbons re-
6934 ferred to, so as to produce a material difference in the action of the carbons when in use.

14 Q. Dr. Barker, in his direct examination (in answer to question 5) also says in substance, in relation to claim one of the patent in suit, that the words "made as described" are to be understood as meaning the reduction of the material of the burner to form before carbonization; adding that, so far as he knows, it is "only by shaping the material and then carbonizing
6935 it," that a burner can be produced having the characteristics of "the filament of carbon of high resistance" of the first claim.

How far do you agree with Dr. Barker in this interpretation of the words "made as described?"

A. I disagree entirely with Dr. Barker in his view of the meaning of these words. It is certainly a fact that the specific resistance of such a conductor as he refers to will be the same whether this conductor is shaped prior to carbonization or is cut out from mate-
6936 rial previously carbonized, and this I understand Prof. Barker to admit in his answer to cross-interrogatory 176.

As I understand the expression "made as described," it refers to the manner of constructing the burner which is set forth in the specification. A burner constructed by the process of *simple* "carbonization" referred to in patent, without special treatment tending to lower

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its specific resistance, is well adapted to produce a carbon having the high specific resistance called for by the claim.

It seems to me, therefore, that the expression "made as described" refers, among other things, to the particular method of construction set forth in the specification, whereby the burner is produced by the process of carbonization pure and simple, without any associated treatment tending to reduce the porosity of the carbon as resulting from carbonization alone. 6938

In addition to the above, it is my opinion that the words "made as described," in claim one of the patent, include the condition that the burner shall be *coiled into a spiral*, or similarly arranged, so as to reduce the effective radiating surface, and I understand that this is to be done previous to carbonization.

That this process of coiling is referred to in the words of the claim "made as described," seems to me to follow from the fact that the specification lays great 6939
stress upon the advantage of this construction, and that it is embodied in the description of the process of forming and carbonizing the conductors. This process is particularly described in lines 37 to 56 on page 2. In the paragraph immediately preceding—lines 30 to 36—the patentee refers to various materials which he has experimented with, and with reference to some of them says that they are shaped into the form of wires of various lengths and diameters, manifestly before carbonization, the inference being that the others are 6940
also shaped prior to carbonization. Then in the paragraph beginning on line 37 he says:

> "If the carbon thread" (that is, the carbon wire referred to in the previous paragraph) "is liable to be distorted during carbonization it is to be coiled between a helix of "copper wire."

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He then describes the attachment of the carbon wire to the leading wires, the carbonization and the subsequent removal of the copper helix. In the paragraph beginning at line 52 he says:

> "With substances that are not greatly dis-
> "torted in carbonizing they may be coated
> "with a non-conducting non-carbonizable
> "substance which allows one coil or turn of
> "the carbon to rest and be supported by the
> 6942 "other."

It thus appears that the patentee divides all of the materials which he proposes to use into two classes, one liable to be distorted during carbonization and the other not liable to be greatly distorted; *and he gives directions for keeping the material of each class in a spiral form during carbonization.*

The subsequent part of the specification referring to the drawings describes only a spiral; the drawings
6943 distinctly show the spiral form; and there is no reference anywhere in the specification to the use of any other form in an actual operative lamp, but, on the contrary, the patentee lays considerable stress upon the advantages of the spiral form.

For these reasons I understand the expression "made as described," in the first claim, to refer only incidentally to the shaping of the carbon burner prior to carbonization. Their real significance is found in their reference to the treatment of the shaped mate-
6944 rial by the process of simple carbonization alone, without any connected treatment calculated to materially lower the specific resistance of the product; and the words also refer to the giving to the burner the form of a closely coiled helix, which apparently requires that the crude material be shaped before it is carbonized.

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The importance which Mr. Edison attached to the absence of treatment tending to reduce the specific resistance subsequent to carbonization, is more fully developed by him elsewhere, and particularly in his testimony in the McKeesport suit. In answer to Q. 432 in his deposition in that case, he says:

> "Taking such a theoretically perfect fila-
> "ment of carbon (composed of carbon cells,
> "with air spaces in each cell) the amount of
> "investment in copper conductors will be in 6946
> "proportion to the amount of carbon in the
> "filament. If the cells were filled solid, full
> "of carbon, the investment in a station using
> "such a lamp, covering a mile area of the
> "city of New York, would probably be, say
> "two hundred thousand dollars for the cop-
> "per; whereas, if the cells were not filled solid,
> "the investment would be, say one hundred
> "thousand dollars; yet the economy and
> "life of the lamp would practically be the 6947
> "same. The carbon of the interior of a fila-
> "ment is a positive disadvantage, because it
> "does not give light, and requires a large in-
> "vestment in copper to carry the current
> "necessary to keep it up to such a degree of
> "incandescence as to permit the exterior of
> "the carbon to emit light."

Again, the importance which Mr. Edison attached 6948
to the high specific resistance resulting from the simple process of carbonization unaccompanied by any form of treatment tending to reduce the porosity thus produced, is emphasized by him in the British patent No. 3,765, heretofore referred to by me, granted to his agent Brewer, September 16, 1880. In this patent, after describing the old process of making carbons, whereby the resistance was reduced by filling the

6949 pores of the original carbons with other carbon deposited therein by introducing carbonizable material and subjecting the same to a carbonizing heat, he says:

> "Such carbons are unfit for use in electric
> "lamps giving light by incandescence. For
> "such lamps said Edison has discovered that
> "the incandescing material should have the
> 6950 "highest possible resistance in a very small
> "bulk, and be capable of resisting the disin-
> "tegrating effects of very high heats and the
> "absence of atmospheric pressure, and fur-
> "ther, that carbons which are purely struc-
> "tural in character alone possess these quali-
> "ties. By purely structural is meant a car-
> "bon wherein the natural structure, cellular
> "or otherwise, of the original material is
> "preserved unaltered; that is, not modified
> 6951 "by any treatment which tends to fill up the
> "cells or pores with unstructural carbon, or
> "to increase its density, or to alter its resist-
> "ance."

15 Q. Are there any advantages secured by the spiral or coiled form, given to the carbon of the patent in suit, which would not be secured by using a straight carbon or wire, or one in the form of a plain loop?

A. There are such advantages, and some of these are referred to in the specification. By coiling the burner
6952 in the manner shown and described in the patent, the effective radiating surface is greatly reduced; and it results from this that for a given illuminating power a much greater length of wire or thread of a given size may be used, and the total resistance of the burner may thus be greatly increased and thus specially adapted to the work that Mr. Edison had in mind. I understand that this advantage is distinctly referred to

in the patent where the patentee, at lines 72 to 79 of the first page, says that by using the coiled form as high a resistance as two thousand ohms may be obtained with a radiating surface of only three-sixteenths of an inch. 6953

Decreasing the radiating surface by using the coiled form also allows a higher temperature to be maintained in the burner with a given expenditure of electrical energy, the size and length of the wire remaining the same; and this results in high efficiency in the lamp, since an increase of temperature of the burner is 6954
accomplished by a vastly greater increase in the amount of light produced. This advantage is, as I understand, referred to by the patentee in general terms at lines 20 to 24 on page 2, where the further advantage of increased steadiness of the light with an unsteady current is also mentioned.

In addition to this the carbon burner is brought into more compact form and given greater mechanical strength to resist shocks, both of which are of great practical importance for very long and thin carbon, 6955
such as would have to be used for the very high resistances mentioned in the patent.

16 Q. What is the meaning in claim one of the patent in suit, of the concluding words, "as set forth"?

A. I understand these words to refer to the preceding clause, "secured to metallic wires," and to indicate that the burner of the electric lamp claimed in claim one is to be secured to the platinum leading-in wires by the process set forth in the specification, namely, 6956
by the use of a carbonizable plastic material molded about the platinum wires prior to the carbonization of the burner, this process avoiding the use of clamps which had previously been customary.

The patentee, as I understand him, states that his burner, (to which he has given variously the names "wire," "sheet," "strip," "thread," and "filament")

6957 is so fragile that it is impossible to secure practical contact between it and the conducting wires by the use of clamps; and because of this he devised, and in his patent describes, the new mode of effecting the union by the use of his plastic compound. Manifestly it is to this passage of his specification that the words, "as set forth," of claim one refer.

If the words "as set forth" do not limit the words "secured to metallic wires," then it seems to me that
6958 the latter words become mere surplusage in the claim, since it is necessary to all incandescent lamps that the burner be secured to metallic wires in some way, and therefore, of course, it would be unnecessary to make mention of this fact in the claim unless for the purpose of calling attention to the particular mode by which the union to the metallic wires is to be effected.

17 Q. Claim one of the Edison patent in suit speaks of a "filament." What do you understand this term to mean as used in said claim?

6959 A. While the word "filament" is the onlyone used in this claim to designate the carbon burner, I find that in the specification it is used as synonymous with the word "wire." The latter, in fact, is the *principal* term which in the specification is applied to the conductor or burner; it occurs in the specification not less than six times, while the word *filament* occurs but twice. From these facts I understand that the meaning of claim one would in no wise be altered if the word "wire" were substituted in it for the word "filament."

6960 There is absolutely no statement of dimensions in the specification which serves to distinguish the "wire" (or so-called "filament") used by the patentee from the "rods" said to have been employed by previous inventors. The only distinction attempted by the patent is the very indefinite one of contrasting the total resistances of the two classes of burners. The patent requires that the new burner (also spoken of as "wire"

and as "filament") shall have a high total resistance as compared with that of the old burners, which are said to have ranged from 1 to 4 ohms. The lowest resistance which the patent puts in contrast with these alleged old resistances is that of a carbonized cotton thread ranging from 100 to 500 ohms, and the highest of which mention is made is 2000 ohms. From this I infer that the patentee did not regard a total resistance of less than 100 ohms (by which, as the context shows, he must have meant the resistance *hot*) as the "high 6962
resistance" that in his own estimation would distinguish his burner from the low-resistance burners of the old lamps.

With this understanding it follows that the thing called "filament" in claim one must have a resistance hot of not less than 100 ohms.

Another possible, but I do not think philosophical or tenable, interpretation of the the term "filament," as the term is used in the claim in question, is that it signifies a burner having a resistance sufficiently high 6963
to enable the lamp to be used in a simple parallel circuit in large numbers in central-station lighting. By simple parallel circuit I mean a parallel or multiple-arc arrangement pure and simple, without the addition thereto, or employment in connection therewith, of any methods of distribution which were not known to the art at the date of the Edison patent in suit.

This understanding of the meaning of the term would give a limit not lower than the lowest resistance mentioned in the specification, namely, 100 ohms; because 6964
with any system of electrical distribution known to the art at the date of the patent, it would have been impossible to use a lamp of lower resistance in multiple arc in large numbers, in the manner contemplated by the patent; and in my opinion, for the extended distribution of the light which it was the object of the patented invention to secure, a much higher total resistance than this would have been necessary.

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If the word "filament" in claim one is not to be interpreted as having one of the meanings which I have thus indicated as possible, it seems to me to be so entirely indefinite that the carbon wire designated by this term is in no wise distinguished from the carbon rods referred to in the patent as having been previously used.

18 Q. It appears from the evidence in this case that
6966 before the date of the patent in suit carbons were known to the art having a diameter as small as one millimetre, and that such carbons were used in incandescent lighting. If such should be proposed as a definition of the term "filament," as used in claim one of the patent, (or the synonymous term "wire" as used in the specification), that it signifies a burner so small in cross-section that the platinum wire necessary to supply it with the current requisite for incandescence will in its turn be so small that a secure seal can be made
6967 by fusing the glass of the globe directly upon the wire, would such definition include the old carbons above referred to?

A. It would, since with platinum wires of abundant size to convey the current necessary for bringing millimetre carbons to perfect incandescence, there would be no difficulty whatever in fusing the wires into the glass so as to maintain a perfect seal. There are many lamps in practical use today which have burners of a diameter of little if any less than this amount, and
6968 whose leading-in wires are of platinum fused into the glass.

19 Q. When the Edison patent speaks of the resistances of the various substances named as being 100, 500, 2000 ohms, and so forth, what is the condition of the carbon as to temperature when these measurements are made?

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A. I understand these statements as to the value of the resistance, to refer to the condition of the carbon when brought to incandescence; in other words, it is the effective resistance, or as the patent states it, "the resistance to the passage of the current,"—what technically is called "resistance *hot*."

20 Q. Have you examined the two specimens of Defendant's lamps in evidence in this case and read the stipulation in regard to their construction; and, if so, 6970
please state whether defendant's lamps embody the invention covered by claim one of the patent in suit—giving your reasons?

A. I have read the stipulation and examined the lamps referred to. In my opinion neither of these lamps embodies the invention set forth in claim one of the patent in suit.

Neither of these lamps is made in the manner described in the specification of the Edison patent, nor in any equivalent manner so as to produce the same re- 6971
sult. The burners are secured to the platinum leading-in wires by *clamps*, and not by the use of plastic material molded about the wires prior to carbonization, as described in the specification. The mode of union thus adopted is one which the patent says is impossible with the patented burner.

Neither is the burner coiled into a helix, nor arranged in any similar manner, but it is so arranged that effective radiation takes place from the entire surface.

Moreover, as appears from the evidence of the wit- 6972
ness, James A. Vandergrift, the burners in these lamps are not made by the process of simple carbonization described in the patent in suit, but are subjected to the process of hydro-carbon treatment, whereby their specific resistance has been reduced about 90 per cent. in the case of the paper lamps, and 50 per cent. in the case of the tamadine lamp; and it appears from the evidence of Dr. Morton in this case (in answer to 50 Qs

6973 that the specific resistance of the carbons of these lamps is not materially different from the specific resistance of arc-light carbons and other carbons such as are referred to in the patent in suit as rods.

From this it seems evident that not only is the process of making the carbon in defendant's lamps essentially different from that described in the patent, but that this difference results in a low specific resistance as distinguished from the high specific resistance which
6974 is in terms made one of the essentials of the burner of claim one.

Moreover, if the term "filament" as used in this claim imports a high effective resistance so that the lamps may be used in large numbers in multiple-arc for the purpose contemplated by the patent, with the modes of distribution known to the art at the time the patent issued, then two of the defendant's lamps—namely, the zigzag paper lamp and the M lamp—for this reason also fail to meet the requirements of claim
6975 one; since, as I have already stated, no lower limit than 100 ohms hot can be assumed for such effective resistance, and the resistance of defendant's zigzag paper lamp is 75 ohms, and of defendant's M lamp 41 ohms, as stated by Dr. Morton.

So, likewise, if "filament" in this claim imports a resistance hot of substantially 100 ohms, irrespective of the extent of use of which the lamp may be capable, it is manifest, for this reason also, that the two lamps named do not embody the invention of the claim.

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21 Q. Referring to claim 2 of the patent in suit, please state whether, in your opinion, defendant's lamps contain the "filaments" spoken of therein?

A. In this claim, as in claim 1, it seems to me that the word "filament" is used as synonymous with the word "wire," which latter term is the chief one used in the specification to designate the burner. Therefore, I do not see that any inference as to the size or

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proportions of the burner can be drawn from the use in this claim of the term *filament*, since in the electrical arts *wires* have a very wide range in size, varying all the way from 1-1,000 of an inch or less up to over ¼ of an inch.

If, however, the term filament, as used in claim 2, is to be interpreted by reference to the *total* resistance of the burner, it seems to me that two of defendant's lamps do not embody the invention of the claim. As
I have heretofore stated, a lamp could not be used in 6978
large numbers, for the purposes and in the way contemplated by the patent, with the modes of electrical distribution known to the art at the date of the patent, if its total resistance hot was less than 100 ohms, and I think that in fact a much higher resistance would be necessary. One hundred ohms, however, as I have already pointed out, is the minimum limit of the "high resistance" which the patent makes an essential feature of the new lamp when contrasting it with the old
lamps. If, then, this limit of total resistance be taken 6979
as indicative of what constitutes a filament, it follows, of course, that neither defendant's zigzag paper lamp (which has a resistance hot of only 75 ohms) nor defendant's M lamp (which has a resistance hot of only 41 ohms) uses the filament of the claim in question.

That Mr. Edison intended to limit himself to a burner having a total resistance of substantially 100 ohms hot, seems to me to derive support not only from the language of the patent in suit but also from his
statement found in U. S. patent No. 369,280, taken by 6980
him August 30, 1887, which was applied for February 5, 1880, only nine days after the issue of the patent in suit. In the patent referred to he says:

> "In lights heretofore proposed the endeavor seems to have been to lessen the resistance of the carbon, none having been suggested of higher resistance than, say, ten ohms; but I have discovered that a

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"very much higher resistance—say one hundred ohms—must be used in order that a number (of lamps) may be economically and successfully used in a system."

So, also, in Edison's British patent 3765 of 1880, granted to his agent Brewer, language is found showing that he regarded a resistance of substantially 100 ohms as the lowest that could be used in practice. The patent says:

6982 "In practice the incandescing conductor of a lamp should be of about one hundred ohms resistance. While this may be varied within certain limits, the resistance stated is a preferable one, and is a very high resistance compared to the carbons referred to as previously used. It is essential that this high resistance should be had without increase of radiating surface, that is, only

6983 the radiating surface necessary to give a certain standard amount of light at the proper degree of incandescence should be used."

I find further and, as it seems to me, stronger evidence that Mr. Edison intended to limit himself to a burner having a total resistance of not less than one hundred ohms hot, in the testimony which he gave in the interference between his paper-carbon application and the application of Sawyer and Man for the patent

6984 which was subsequently granted the persons last named, and which became the subject of the McKeesport suit. In his testimony in that interference (as the same is printed on page 171 of defendant's record, Vol. I., in the Mckeesport suit), referring to the time of his experiments which led to the invention by him of the paper-carbon burners, he says (italics mine):

"What we desired at that date, and had

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"concluded as the only possible solution of the subdivision of the electric light, was that the lamp must have a high resistance and small radiating surface, so as to be capable of being worked in multiple arc commercially, and *our calculations showed us that the lamps must have at least 100 ohms resistance* to compete successfully with gas, otherwise, if the lamps were of low resistance, the cost of the main conductors would be so great as to render the system uncom- 6986 mercial."

This testimony of Mr. Edison was given some time subsequent to the issue of the patent in suit.

I also find further on in the same case, on page 188 of the same printed volume, the following question and answer:

"46 Q. What was the resistance of the lamps made by you in the latter part of 1879?

"A. Some of them were as high as 1,000 6987 ohms, but the average resistance of the paper carbon was about 100 ohms when hot."

In another British patent granted to Mr. Edison, No. 602 of Feb. 11, 1880, I find the following statement in regard to the resistance of incandescent lamps to be used in Edison's multiple-arc system of distribution:

"In the house, each translating device is placed in the derived circuit, the entire sys- 6988 tem of mains for generation, conduction, and translation being one great multiple-arc system. The translating device in each house may be either for light or power, or both. For light, the electric lamp consisting of an incandescing material hermetically sealed in glass is preferred. This lamp should be of a high resistance in comparison with the

6989 "resistance of any electric lamp which to my
"knowledge has hitherto been proposed. The
"endeavor seems to have been to lessen the
"resistance of the carbon, but I have discov-
"ered that a very high resistance, say 100
"ohms, must be used in order that a number
"may be economically and successfully used
"in the system."

6990 Also in Mr. Edison's English patent No. 2402, dated
June 17, 1879, which corresponds in general terms to
his United States patent No. 227,229, for his high-re-
sistance platinum lamp, I find the following statements
(italics mine):

"I will now describe the form of burner or
"lamp which I employ. To operate several
"hundred electric lamps practically, each
"equal to an ordinary gas jet, upon one cir-
6991 "cuit, it is essential for many reasons, both on
"the score of economy, facility, and reliabili-
"ty to place them all in multiple arc, and to
"prevent the combined resistance of several
"hundred lamps from falling to such a low
"point as to require main conductors of im
"mense dimensions with low resistance, and
"generating machines of corresponding char-
"acter, it is essential to reverse the present
"and almost universal practice of using lamps
6992 "which shall have but one or two ohms resis-
"tance, and construct lamps which shall have,
"when given their proper light, *a resistance*
"*of several hundred ohms*, because the more
"lamps there are in the circuit the less will be
"the resistance. I have ascertained by ex-
"periment that the loss of energy is in propor-
"tion to the extent of the radiating surface
"independent of the resistance of the conduc-
"tor; hence we have 100 lamps, each of ¼
"of an inch radiating surface, and each of
"ohm resistance, or 1,000 lamps having the

"same radiating surface and 1,000 ohms re- 6993
"sistance each; the loss of energy from each
"lamp when giving each a light of fifteen can-
"dles will be nearly the same, but the com-
"bined resistance of the 1-ohm lamps will
"be 1-1000 of an ohm, requiring an enormous
"main conductor, whereas the combined re-
"sistance of the 1,000-ohm lamp will be 1-
"ohm, requiring a conductor of very moder-
"ate dimensions. *In practice a resistance of* 6994
"*200 to 300 ohms in the burner will be suffi-*
"*cient.*"

The complete specification of this patent appears to
have been filed on December 17th, 1879; *and it thus
appears that at about the time when the patent in suit
was taken out, Mr. Edison considered a much higher re-
sistance than 100 ohms as no more than sufficient for the
same purposes of distribution which are set forth in the
patent in suit.*

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In addition to the above there is another reason, ap-
plicable to all three of defendant's lamps, which leads
me to the opinion that no one of these lamps embod-
ies the invention to which the second claim of the
patent in suit relates.

The concluding words of the claim, "for the purpos-
es set forth," call special attention to the object of the
invention as stated in the body of the specification.
Referring to the specification, the object as there given
is to secure "the practical subdivision of the electric 6996
light," with electric lamps operating by incandescence;
and further on in the specification, it appears that this
general statement, according to the conception of the
patentee, requires that the lamps be so organized that
they can be "worked in great numbers in multiple arc
without the employment of main conductors of enor-
mous dimensions"—meaning, of course, with the modes
of electricial distribution known at the date of the pat-
ent.

6997 Now, I find no suggestion in the patent that Mr. Edison designed as a part of his contribution to the art to make use of lamps in which the carbon burner was not to be coiled into a close spiral, or, at any rate, arranged on some similar plan whereby only a portion of the external surface of the burner would be an effective light-radiating surface. On the contrary, his statements of invention, as made in the opening paragraphs of the specification, seem to me to require as an essential of the invention as patented, that the
6998 burner be thus coiled or arranged.

These paragraphs are as follows—italics mine:

> "The invention consists in a light-giving "body of carbon wire or sheets *coiled* or "arranged in such a manner as to offer great "resistance to the passage of the electric "current, *and at the same time present but a "slight surface from which radiation can take "place.*

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> "The invention further consists in placing "*such* burner of great resistance in a nearly "perfect vacuum to prevent oxidization and "injury to the conductor by the atmosphere. "The current is conducted into the vacuum "bulb through platina wires sealed into the "glass."

Manifestly, the first of these two paragraphs corresponds to claim 3 of the patent, while the second
7000 paragraph is the one upon which claim 2 is predicated; and it is also manifest that the word "such" in the second paragraph requires that the burner thus designated (being the burner or filament of claim 2) shall be "coiled," or, if not coiled, "arranged in such "a manner as to offer great resistance to the passage of "the electric current, and at the same time present "but a slight surface from which radiation can take "place"—that is, it must be so arranged, either by coiling

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or in some other equivalent manner, that great length, and thus great total resistance, can be secured without too much increasing the radiating surface and thus the volume of the light, this latter being prevented by the peculiar arrangement which masks and thus renders non-effective as light-radiating surface a portion of the total external surface of the burner.

As above stated by me, it is obvious that the second paragraph of the statement of invention, as above quoted, is the paragraph which corresponds to the 7002 second claim. My reason for this is, that claim 2 is the only claim which makes any reference in terms to the enclosing glass globe and to the vacuum, and the second paragraph of the statement of invention is likewise the only paragraph in the whole statement of invention which makes any reference to these two features.

As I understand it, great weight always attaches to the statement of invention usually found in the opening part of a patent specification. Such statement is 7003 intended to give the most comprehensive description of the patentee's invention, and is usually drawn with great care. In the present case, as this statement of invention excludes the idea of a lamp in which the burner is not coiled into a spiral or similarly arranged, it seems to me that the claim now in question—claim 2—must be construed as limited, among other things, to a burner having such a form.

Assuming the claim to be limited as indicated, it is manifest that no one of defendant's three lamps 7004 embodies the invention to which it relates, since the burners are neither coiled nor otherwise arranged so as to comply with the conditions above expressed; the arrangement of the burner in neither of these lamps is such as to sensibly limit the radiating surface.

In interpreting claim 2 as I have done above, I have not failed to notice Mr. Edison's statement in his patent

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that he has discovered "that even a cotton thread "properly carbonized and placed in a sealed glass globe "exhausted to one-millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of the current;" but I do not in this statement find anything to indicate that he intended or deemed it practicable to make use, for the wide distribution of the electric light which the patent contemplates, of lamps with carbon burners which were not coiled into a helix, or other-
7006 wise arranged so as to give the same results as the spiral coiling. Apparently Mr. Edison refers to his alleged discovery that carbonized cotton threads with a resistance of from 100 to 500 ohms will endure in a high vacuum, together with his further discovery that by coiling such thread sufficiently he can secure a resistance of 2000 ohms, simply for the purpose of establishing the extreme limits of possible resistances which he deemed "*high*" as compared with the old resistances; and these statements undoubtedly were
7007 predicated upon mere laboratory experiments, and, so far as they can be assumed to relate to carbon threads not coiled, without any thought that he could secure the resistance and stability and smallness of radiating surface requisite for the use of the lamps in large numbers in multiple arc otherwise than by coiling the carbon, or disposing of it in some similar manner. I do not see that anything in the passage under consideration can be regarded as enlarging the scope of the invention beyond the limitation established by the very explicit language used in the statement of invention in
7008 the third paragraph of the specification as heretofore quoted by me, which paragraph seems conclusive that Mr. Edison intended to limit himself in this patent to the use of carbons that are coiled into a spiral or are similarly arranged.

22 Q. What would you say to adopting as an ex-

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planation of the term "filament," as used in claim 2, the definition that it is a burner of such high total resistance (due to the combined factors of specific resistance, area of cross-section and length) that the lamp can be used in large numbers in multiple-arc distribution in *competition with other illuminants?*

A. Such a definition would, in my opinion, be entirely vague, and therefore untenable. The characteristics of the burner which could be used as supposed in the question would be subject to the widest variations from causes having nothing whatever to do with 7010
the actual properties or proportions of the filament itself, or, indeed, of anything connected with the production of light by incandescence.

The resistance of the burner which could thus be used would vary with the price at which gas could be produced and sold, with the market price of copper, with the cost of labor, with variations in degree of perfection of the steam engine or other motors used, and with the current rate of interest on investments. I fail to see how a definition of filament which is thus 7011
vague and incapable of determination could be held as the sense in which that term is used in the patent. Accepting such a definition as is suggested in the question, every circumstance which influences the cost of the production and delivery of gas on the one hand, and of electricity on the other, would enter as a factor to vary the minimum permissible resistance, and thus to affect the size of the thing called a filament.

Thus it is evident that the higher the resistance of the burner, other things remaining the same, the less 7012
current will flow through each lamp, and hence the smaller will be the size of the leading wires necessary to furnish the needful current for a given number of lamps. So, also, the cost of running the dynamo machines which furnish this current will be less in proportion as the engines used are more perfect.

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23 Q. With any of the methods of electrical distribution known to the art at the date of the patent in suit, please explain the relations existing between the size and proportions of the burner of an incandescent lamp and the character of the circuit in which the lamp is to be used?

A. There were two fundamental methods of electrical distribution known and practiced in the art of electricity at the date of the Edison patent. In the first
7014 of these the various translating devices employed are arranged one after the other in a series, so that the electricity passes successively from one translating device into the next and so on throughout the whole circuit, the entire current passing through each device. This is illustrated in the diagram entitled "Series Arrangement," given by Prof. Morton in connection with his answer to question 7 of his deposition in this suit.

In the second method of arrangement the various
7015 translating devices are placed so as to form separate branches or bridges, as it were, between two main leading wires; the total current of electricity flowing from the generator into one of the mains, and then splitting up into as many separate smaller currents as there are different translating devices, a fractional part of the total current flowing through each device. This method of arrangement is illustrated by Prof. Morton in the figures labeled "Multiple-arc or Parallel Arrangement." The particular arrangement that I have specifically described is figured in diagram No. 2.
7016 Diagram No. 1 is substantially the same thing except that the earth is substituted for the return wire—a well-known mode of procedure.

Considering, first, the series arrangement of lamps, it is evident that, since the same current flows through all of them, if any very large number are to be placed in circuit it will be necessary to make the resistance

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of the separate translating devices comparatively low since, if this were not done, the electro-motive force or electrical pressure which would be necessary to force a current through the high resistance furnished by the whole series of translating devices would be so great that its use would be impracticable.

On the other hand, with a parallel arrangement of translating devices, and a constant electrical pressure maintained in the mains, it is clear that the quantity of electricity flowing through each one of the translat- 7018
ing devices will be less in proportion as the resistance of the device is greater; so that by raising the resistance of the translating devices the current flowing through each will be reduced, thus obviating the necessity of having an excessively large current in the mains, and so avoiding giving to these mains an excessively large section.

These principles, that the resistance of electrical translating devices in series should be made relatively low, and that the resistance of such devices arranged in 7019
parallel should be made high, so far as is consistent with other requisites, were well known in the arts and of universal application long prior to the date of the Edison patent.

It was also well known that the resistance of a wire or other conductor was most readily diminished by making it short and thick, and most readily increased by making it long and fine; and this principle was frequently employed in choosing the dimensions of wires to be brought to incandescence by the electrical cur- 7020
rent.

These principles were also fully recognized and well known in their application to electrical incandescent lamps at the date of the Edison patent. Thus, in Nature, published at London on June 5, 1879, Vol. XX, page 139, these principles are set forth as a matter of electrical engineering in the abstract of a paper read before the Physical Society of London, by Mr. Wilson,

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in which there are very clear statements of the evident applicationof the familiar electrical principles to this subject. The same fact is also clearly recognized in British patents to Lane-Fox Nos. 3988 and 4043 of 1878 and No. 1122 of 1879; and in United States Patent No. 227,229 issued to Thomas A. Edison, May 4, 1880, on his application of April, 1879, as also in his corresponding French and Italian patents of May and June, 1879.

7022 The abstract in Nature of Wilson's paper, referred to above is as follows:

"Mr. Wilson then read a paper on the di-
" visibility of the electric light by incandes-
" cence. By Joule's law the amount of heat
" developed in a circuit of resistance, R, by
" the passage of a current C=C² R; where
" R is the resistance of generator and connec-
" tions, *r*, added to the resistance of the light
7023 " emitter or incandescent wire, P. Therefore,
" since by Ohm's law $C=\frac{E}{R}$ we have:

$$C^2=\frac{E^2}{(r+P)^2}, \text{ and } \frac{C^2 P}{(r+P)^2};$$

" From this equation the value of P may
" also be determined. C^2 P is the amount of
" heat developed in the incandescent wire.
" He infers that the smaller the mass of wire
" the higher the temperature generated in it:
" therefore the mass of the wire should be
7024 " diminished until the fusing point of the
" metal is almost attained. The question of
" divisibility resolves itself into our being able
" to divide a single incandescent source into a
" number of smaller ones giving the same to-
" tal illumination. The author concludes that
" this can be done by arranging the subdivided
" sources in 'multiple arc' or parallel circuits,
" provided the total mass, length and sec-

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" tional area of the united sources be
" the same as in the original single source.
" The objection that increased radiation from
" the various sources would diminish the first
" total of light and heat can be met by mak-
" ing the smaller wires still smaller than is
" theoretically required so as to generate more
" heat."

24 Q. Please state whether at the date of the appli- 7026
cation for the Edison patent in suit (November 4, 1879) a person familiar with the laws of electricity would have known the difference as to size and proportions it would have been necessary to make in the burner of an incandescent lamp in order to adapt the lamp to the various conditions of circuit in which it might be found desirable to use it?

A. There is no doubt whatever that at the date referred to in the question, and in fact long prior thereto,
one skilled in the art would have known how to propor- 7026
tion an electric lamp in order to adopt its resistance to working with other lamps, according as they were to be arranged in series or in parallel.

He would unquestionably have known that if it were desired to operate a great number of incandescent lamps in series, the resistance of the burner should be made comparatively low, which, having chosen the material, he would naturally have done by making the burner comparatively short and thick; but still leaving
it thin enough to give the resistance necessary to se- 7028
cure the proper state of incandescence by the current which it was desired to use.

On the other hand, he would unquestionably have known that if the lamp was to be used in parallel in large numbers, its resistance must be suitably proportioned for this purpose by making it sufficiently high, which he would naturally have done by using a burner

7029 comparatively long and fine, keeping in consideration, of course, the necessity of adapting the burner to the electrical and other conditions of the circuit in which it was to be employed, and also the amount of radiating surface required.

25 Q. State whether at a date prior to Mr. Edison's application for the patent in suit the known principles of electrical science were such that a person familiar
7030 with these principles, would, in constructing an incandescent lamp naturally have had special regard to the distance from the source of the current at which such lamp was to be used?

A. They were. For a long time prior to the date referred to, it was a well known principle, and one constantly employed in the construction of electrical translating devices of all kinds, that in order to obtain a high efficiency with any translating device in which the resistance of that device was an effective and helpful
7031 element, the resistance of the device should be high—in fact, as high as possible—in proportion to the resistance of the remaining portions of the circuit. If, therefore, the resistance of these remaining portions of the circuit was very low, then the translating device might be efficient although its own resistance was likewise low; but, on the other hand, if the resistance of the other portions of the circuit was necessarily high—it followed that the resistance of the translating device would of necessity have to be correspondingly increased
7032 in order that it might continue to possess a high degree of efficiency.

If, for example, the translating device were to be used in immediate proximity to the generator, then, provided the resistance of the translating device was high in proportion to that of the generator, even though low absolutely, a high efficiency would be obtained. In this case the resistance of the leading wires, if those

were of moderate size, would be inconsiderable and negligible. 7033

On the other hand, if the translating device were removed to a great distance from the generator, it is clear that if the leading wires remained of the same section, their resistance might form a very large portion of the total resistance of the circuit—perhaps very much larger than the resistance of the translating device itself; in which case the efficiency of the translating device would be very low. Its efficiency could, of 7034
course, be raised by increasing the size of the conducting wires, so that the total resistance even of the very long wires should be no greater than the total resistance of the very short conducting wires necessary when the translating device was close to the generator; but this of course would be a costly proceeding, and one, therefore, which could not be used to any considerable extent in practice.

An alternative mode of increasing the efficiency of the translating device when removed a great distance 7035
from the generator, would be to leave the size of the main conductors small, although this would give them a high resistance, but to increase the resistance of the translating device, the efficiency of this device becoming greater as its resistance is increased. If the resistance of the translating device is increased until it exceeds the resistance of the rest of the circuit in the same proportion in which it exceeded that resistance when it was close to the generator, it is clear that its efficiency will be the same as at first, notwithstanding 7036
its greatly increased distance from the generator.

An evident remedy, therefore, for the loss of efficiency otherwise due to a necessary increase in the length of the conducting wires connecting the translating device with the generator, is to proportionately increase the resistance of the translating device itself.

No electrical principle was more familiar than this one, either in theory or in its practical applications.

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Thus in telegraphy, ever since the practical introduction of that art, it has been the universal custom to make use of receiving instruments, such as relays sounders, galvanometers and other like translating devices possessing many turns of fine wire, and therefore, having a high resistance, when located at a long distance from the battery. On the other hand, when such electro-magnetic devices are to be used close to the generator, they are made of comparatively low resis-
7038 tance, by employing only a comparatively small number of turns of stout wire. The same principle was used in the construction of instruments for electrical measuring devices. Also it was used in determining the resistance of electrical fuses, which consisted of wires heated to incandescence by the passage of the current of electricity. It was also used, prior to the date of application for Mr. Edison's patent, in the proportioning of dynamo-electric machines and electric lamps in order to obtain the highest possible economy.

7039 There is no question that the application of this principle to an incandescent lamp would have been perfectly clear to one skilled in the art at the time under consideration. Such a person having a lamp of a certain resistance, perhaps a low absolute resistance, which was used close to the generator, and wishing to remove it and to use it at a great distance from the generator, would have seen immediately that if the construction of the lamp were to remain unchanged when placed at a distance from the generator, it would re-
7040 quire the use of conductors of much larger section in order that it might operate with the same efficiency—and very likely in order that it might operate at all, for of course the diminution of the current might be so great as of itself to render the apparatus inoperative.

He would have seen immediately, without the exercise of any invention, but by a most obvious application of the general principle under considera-

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tion, that if he should make use of conducting wires of moderate dimensions, he could cause his lamp to retain its original efficiency by the simple expedient of increasing its resistance—that is, by employing a long and thin burner instead of using a short and thick one. This process would have been directly in the line of practice universally followed in the construction of electro-magnets and like devices, in which, when the electro-magnet was near to the generator, a short and stout coil of wire of low resistance was employed, 7042
while when it was at a distance from the generator a long and fine coil of wire was used.

From the facts which I have stated, it seems to me without question that a person familiar with the art at the date referred to in the question, and, in fact, long prior thereto, would, in the construction of an incandescent lamp, have taken account of the distance from the generator at which the lamp was to be used, and that he would have known precisely what peculiarities of construction must be given to it by reason of the 7043
various distances.

26 Q. In the last answer you have dealt with a *single* lamp, and the relation existing between such lamp and the size of the conducting wires, according as such lamp was to be used near the source of energy or at a distance. Please state whether the principles which you have thus laid down with reference to a *single* lamp as principles perfectly familiar to a person skilled in the art prior to Mr. Edison's application for 7044
the patent in suit, would also have been known to such persons as applicable to a *group* of lamps, larger or smaller, and whether designed for use in series or in parallel?

A. The principles under consideration were perfectly well known to those skilled in the art as applicable either to a single translating device or to a group of translating devices, arranged in any manner what-

7045 ever;—that is, whether in series, or in parallel, or in multiple series. The variation in construction of the individual members of such a group according to the resistance of the other portions of the circuit, was perfectly well understood. Moreover, these principles were constantly applied in the construction of various forms of translating devices which were operated in groups from a single generator.

Hence it is perfectly clear to my mind, that a person skilled in the art, and desiring to operate incandescent
7046 lamps under various circumstances as to grouping and distance from the generator, would as a matter of course have applied the principles under consideration and so varied the resistance of the individual lamps as to secure the desired efficiency whether the lamps were near to the generator or at a distance from it. To this end he would undoubtedly have made the resistance of the lamps higher when they were to be used at a great distance from the generator than he would have found it necessary to make them if they
7047 were to be used near by.

27 Q. Are you familiar with the commercial lamps of the present day known as the Bernstein lamps, the Edison Municipal lamps and the Thomson-Houston series lamps?

A. I am.

28 Q. Could any of these lamps be used in large numbers in multiple-arc with any system of electrical
7048 distribution known to the art at the date of the Edison patent in suit?

A. They could not, because it would involve the use of mains of such size as to be prohibitory.

29 Q. If at the date of the patent in suit (or, for that matter, years prior thereto) a lamp like the Bernstein, or an Edison Municipal lamp, or a Thomson-

Houston series lamp, had been shown and explained to a person familiar with the laws of electricity, and such person had been requested to construct or to direct the construction of other lamps of the same general character, but so changed as to be adapted for general use in multiple-arc, the candle power of the lamps being the same, would such person have known what changes it would have been necessary to make in the size and proportions of the carbon burner to adapt such lamp to the new conditions of use? 7050

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A. In my opinion, he would have known this. It would have been clear to him immediately that the burner, instead of being comparatively short and thick, thus presenting a relatively low resistance, would have to be made comparatively long and thin, so as to present increased resistance, and thus become incandescent with the passage of a relatively small current. It would, of course, have been evident to such a person that a simple reduction in the cross-section alone would not suffice, since this would not allow sufficient 7051 radiating surface; while, on the other hand, it would have been equally clear that the necessary characteristics could not be gained by a simple increase in length, since this would unduly increase the radiating surface, and hence the illuminating power of the lamp. Consequently, under the conditions of the question, the person referred to would have known that the burner of the lamp would have to be changed, both by diminishing the cross-section and by increasing the length. 7052

30 Q. You have heretofore referred to the Edison United States patent No. 227,229, dated May 4, 1880, granted on an application filed in April, 1879, in which there is shown and described an incandescent lamp which, as appears by the proofs in this suit, was also patented in France and Italy in May and June of

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1879. Please state whether, in your opinion, it would have required invention in June, 1879, for a person skilled in the art and familiar with the incandescent lamp shown and described in the patents referred to, to substitute in the all-glass and highly exhausted globe of said lamp a carbon burner in place of the platinum wire which forms the burner of said lamp—aside from any difficulties that might be involved in the actual making of the carbon burner to be substituted
7054 for the platinum burner, and aside also from any difficulty connected with the uniting of such carbon burners to the leading-in wires?

A. In my opinion, it would not have involved the slightest invention to make the change suggested in the question. Such a change, if the carbon wire were at hand, would be of precisely the same nature as that of substituting wire of one metal for wire of some other metal, as, for example, the substitution of an improved kind of platinum wire for a wire of ordinary
7055 platinum in an incandescent lamp. The superiority in many respects of carbon over platinum for the burner of an incandescent lamp was well understood for years prior to the date of the Edison patent in suit. These advantages were clearly set forth in a report made by Wild to the St. Petersburg Academy of Science on Lodyguine's lamps in 1874, as I now recall, and published in *Les Mondes*, at Paris, in 1875, Vol. 1, p. 183.

31 Q. Suppose in April, 1879, you had had no
7056 knowledge of any actual lamp made with a carbon burner enclosed in an exhausted all-glass globe, and you had then for the first time been made acquainted with Edison's platinum-lamp structure, as described in his application made at that time and patented in U. S. Patent No. 227,229, and had been requested to make a carbon incandescent lamp that would be capa-

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ble of the same extent of use as is claimed for the platinum lamp in Edison's said patent, would you have known what proportions it would have been necessary to give the carbon burner?

A. I have no doubt that I should have known what proportions to give to the burner. Setting aside all other instructions, I should have known from the structure of Mr. Edison's platinum lamp that the carbon wire ought to have a resistance substantially the same with that of the platinum wire in the platinum lamp, or as near to that as was 7058
practicable with the new material, assuming, of course, that it was to be used on the same circuit. Knowing the specific resistance of carbon and its other physical properties, I should have known approximately what section and length to give to the carbon wire in order that it might replace the platinum in the earlier lamp, and be capable like that lamp of use in large numbers for general purposes of illumination. I should, of course, have known from the construction of the platinum lamp, even if in no other 7059
way, that the section of the carbon wire must be so small that the platinum leading wires would readily convey the current necessary to raise it to incandescence without becoming so heated as to be liable to injure the seal (this condition being explicitly set forth in the specification of the patent mentioned in the question), and the smallness of the carbon wire, together with the total resistance which it was desired to obtain, as well as the amount of radiating surface which was required, would determine the length of 7060
the carbon wire.

32 Q. Would the recognition by you, under the conditions named in the last question, of the size and proportions requisite for the burner of a carbon incandescent lamp designed for use after the manner of Edison's platinum lamp (shown and described in his Patent No. 227, 229), have involved invention?

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A. It would not. The determination of the size and proportions of the burner, under the conditions referred to, would have been a mere application of the commonest principles of electric engineering which were at that time familiar to those skilled in the art.

33 Q. You have referred in your testimony to the British patent of King No. 10,919, of 1845. Please read the answers of Dr. Morton to questions 31 to 38
7062 inclusive, in this suit, in relation to the King lamp, and say whether you agree with the opinions which he has there expressed?

A. I have carefully read the answers to the questions referred to, and I do agree with the opinions Prof. Morton has expressed therein.

34 Q. If at any time prior to or in the year 1878 you had been called upon to make a readily portable carbon incandescent lamp under the King patent, for ordinary
7063 commercial use, how would you have made it; first, as regards the thickness or size of the carbon burner; second, the character of the vacuum to be used; and third, the sealing of the globe?

A. With regard to the *size* of the carbon burner to be used, I should have been governed by the character of the circuit in which the lamp was to be operated and the mode of coupling—whether in parallel or in series—which was to be employed. If the burner was to be used in conjunction with others to be operated
7064 in series upon a circuit, I should have made it comparatively short and thick, in order that its resistance might not be so high that when a number of such lamps were operated in series the electro-motive force would be unduly large. In thus proportioning the burner I should, of course, have had regard also to the extent of radiating surface necessary to give the desired amount of light and to the general conditions of the circuit.

On the other hand, if the lamp was to be operated 7065
in connection with others in parallel, I should have made the carbon burner fine and long, in order to secure the high resistance which with a parallel system is necessary in order to reduce the strength of the total current in the mains necessary to operate a system of lamps. In determining the size of this conductor I should, of course, have been guided by the amount of radiating surface which the burner was to have, and by the electrical pressure which it was 7066
desired to use in the mains of the circuit, if this was given.

In giving to the carbon burner as small a section as is necessary for the purpose which I have mentioned, I should only have been following out the directions which are explicitly given in the British patent of King, that the carbon is to be "worked into the form of small pencils or thin plates," these being, when carbon is used, a substitute for the "exceedingly thin" leaf platinum which the patent also sets forth 7067
as one material for the burner of the lamp.

While the choice of the actual resistance of the King lamp would be determined, as I have thus explained, according as to whether the lamp was to be run with others in series or in parallel, it is true, for obvious reasons, that in both of these cases we should have employed as thin a burner as would be consistent with the various conditions under which the system was to be operated.

It is true the King patent does not give specific 7068
directions as to the particular mode of proportioning the burner to the conditions of the circuit, in that form of the lamp in which the burner is made of carbon; but this was in no wise necessary, since in the earlier part of the patent, when describing a *platinum* burner and the proportions which should be given to *it* with regard to the conditions of the circuit, exceedingly defi-

nite statements are made, which would immediately and necessarily be applied by one constructing a *carbon* burner to the proportioning of *such* burner.

Regarding the platinum burner, the patentee says:

> "A strip is to be cut from one of these "sheets [of thin platinum prepared as previ-"ously described] of a width proportionate to "the quantity of the current, which with Grove "cells having the platinum plates three inches
> 7070 "long and two inches wide is about ¼ of an "inch, and of a length proportionate to the in-"tensity which, of course, varies with the num-"ber of cells."

In this paragraph, to one at all familiar with the use of electrical terms at the date of the King patent, there is a most distinct recognition not only of the necessity of adapting the proportions of the burner to the conditions of the circuit, but also a perfectly plain statement of the precise manner in which the propor-
7071 tions would naturally be varied in order to secure such adaptation. The patentee says that the length of the burner, and consequently its resistance, is to be proportioned to the "intensity," that is, to the electromotive force, of his battery, which, as he says, varies with the number of cells, meaning, evidently, the number of cells in series. If the conditions of the circuit are such that the "quantity" or strength of the current in the circuit is to be great, he then proposes to diminish the resistance of the burner by making it broader. More-
7072 over, the patentee has determined the particular resistance which, in his view and for the purpose which he particularly had in mind, is most suitable for a particular kind of battery, namely, the Grove battery, which at the date of the King patent was the most powerful known source of electric currents; and from his reference to this particular kind of battery and to the

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arrangement of its cells, it seems to me to be perfectly clear that he understood that the proportions of the burner would be dependent upon the electromotive force of the source of electricity as well as upon the conditions of the rest of the circuit.

It appears from this that King distinctly proposed to proportion his burner to the conditions of the circuit, by varying both the length and the cross-section so as to give it a higher or lower resistance as was necessary in any particular case.

The foregoing facts appear to me to fully bear out 7074
the opinions which I expressed in my answers to questions 23, 24 and 25, to the effect that, prior to the date of the Edison patent, one skilled in the art would unquestionably have understood perfectly well that it was necessary to adapt the proportions of his burner to the conditions of the circuit in which it was to be used, and moreover would have understood perfectly the manner in which these proportions should be varied to adapt the burner to different conditions of the circuit.

With regard to the character of the *vacuum* which I 7075
should have used under the conditions, of the question, I should have employed the best vacuum which I knew how to produce practically, since King proposes to employ the Torricellian vacuum, which was universally regarded as the most perfect vacuum procurable, and moreover gives this fact as a reason for using that vacuum. For convenience sake, I should doubtless have chosen to employ the vacua furnished by a Geiss-
ler or Sprengel pump, rather than that obtained by the 7076
direct use of the Torricellian method; the use of these pumps to replace the Torricellian method having been universally known long prior to the date mentioned in the question.

As to the *sealing* of the globe under the conditions of the question, I should have employed platinum wires fused into the glass, a method which, so far as one of

7077
the wires is concerned, is specifically stated and figured in the King patent. My reasons for doing this would have been that for many years prior to the date mentioned in the question, it had been recognized that the readiest way to maintain a high vacuum through which an electrical current was to be carried was by sealing the leading wires into the glass by fusing the glass around them, platinum being universally recognized as the proper metal for this purpose.

7078 Still further, the King patent speaks of a modified form of lamp, with a view of giving durability to the lamp, under conditions that would be inconsistent with the use of the mercury seal used in the lamp shown in the drawing. In my opinion, when the patent says that by "suitably sealing" the lamp it can be made available for submarine lighting and kindred purposes, it intends that the lower end of the lamp shall be sealed up in the same way as the upper end.

7079 This, in fact, has been a well-known mode of procedure for making vacuous chambers into which an electric current was to be carried. Masson, as early as 1852 (as reported in "Annales de Chimie et de Physique," 3d series, 1851, vol. 31, p. 312), exhausted tubes by the Torricellian method, and then sealed them off by fusion.

35 Q. Dr. Morton has spoken of the vacuum of the King lamp secured by the Torricellian method as
7080 "almost perfect." How well can such a vacuum be maintained with the mercury seal which the King patent proposes to use, in the particular form of lamp shown in sheet 2 of the drawing?

A. The mercury seal would, so far as I can see, be a permanent one, and I should expect it to last indefinitely.

I am fortified in this belief by the fact that a lamp in many respects identical with the King lamp as de-

scribed, and possessing the same form of seal, is de- 7081
scribed by Mr. Edison in his United States Patent No. 237,732, dated February 13, 1881. Regarding the seal employed, Mr. Edison says that "this arrangement makes a very reliable and durable seal," and, a little later, that "in large lamps this method may prove preferable to that of sealing direct."

36 Q. You have referred in your testimony heretofore to the British patent of Roberts, No. 14,198, of 7082
1852. Please read the answers of Dr. Morton to questions 46 and 47, and state whether you agree with him in the views which he there sets forth, in regard to the size of the burner, and the character of the vacuum to be employed in the Roberts lamp?

A I have read the answers of Dr. Morton referred to, and coincide with him in his views as to the matters inquired of in your question.

37 Q. If in the year 1878, or prior thereto, you had 7083
been called upon to make lamps under the Roberts patent for commercial use, how would you have made them, as regards the size of the burner and the character of the vacuum?

A. So far as the conductor or burner of the Roberts lamp is concerned, I should have made it of dimensions proportioned according to the character of the circuit in which the lamp was to be operated, making the resistance proportionately higher when the lamps were to be arranged in parallel cir- 7084
cuit, and proportionately lower when in series, as I have already explained with regard to the construction of burners in general. I should have been led to employ burners of small section from the instructions of the patent, which directs the use of a "thin piece of graphite, coke or charcoal;" and, again, directs that the burner shall be "as thin as can con-

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veniently be made" These statements in the patent, together with others of like tenor, would have led me to the employment of burners of as small section as could be made by the known processes, and as would be consistent with the requirements of the particular circuit in which the lamps were to be used. Specific instructions, however, as to size, would have been entirely unnecessary to me at the time mentioned in your question, since such proportioning of the burner is an
7086 immediate and evident consequence of the fundamental principles of electrical engineering.

With regard to the character of the vacuum, to be used, I should have employed that given by a mercury pump, for the reasons which I have already stated in connection with the King lamp in my answer to interrogatory 34. I should have done this, since Roberts directs that the burner of his lamp be placed in as "perfect a vacuum as can conveniently be made and
7087 "obtained," making also other statements of like tenor.

38 Q. You are familiar, I believe, with U. S. Letters Patent No. 205,144 and No. 210,809, granted to Sawyer and Man, respectively, on June 18, 1878, and Dec. 10, 1878?

A. I am.

38½ Q. If in the year 1878 you had been called upon to construct such lamps as are shown and described in said Sawyer and Man patents, and on trial you had
7088 found any leakage of the lamps at the base, would you have known, and, in your opinion, would any person skilled in the art have known under similar circumstances, how to correct such defect; and how would you have done it?

A. In my opinion, any person skilled in the art at the date mentioned in the question, would have known immediately how to proceed to remedy the difficulty of

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leakage with the Sawyer and Man, or similar lamps, in case it was found to exist. It was, and had been for years, a most familiar process to seal in the leading wires of a similar apparatus by fusing the glass of the enclosure about these conductors; and one skilled in the art would have immediately applied this process to the lamp structure in question, if it had been found necessary.

Moreover, with the particular lamps referred to it would have been necessary to fuse together the two 7090
pieces of glass constituting the receiver and the base. This process, however, was an extremely familiar one, having been common in all sorts of glass working for many years, and having constantly been employed in various forms of Geissler's tubes and Crooke's tubes. This, of course, would have involved the use of glass of the proper thickness and of the proper kind to join together by fusion, in accordance with the common practice in making other similar enclosing envelopes of glass; but to a person skilled in the art the selection of 7091
the proper glass for such purpose would have been a matter of mere skill, and would not have involved invention.

This substitution of an "all-glass" vessel, the joints being closed by fusion, in place of a glass vessel made up of two sections united by cement, is admirably illustrated in the various apparatus employed by Crookes in his experiments on radiant matter. In these investigations, Crookes had occasion to make use of vacua of widely varying degrees of tenuity, ranging as high, 7092
in some instances, as 4-10 of one one-millionth of an atmosphere; and he also made use of many different forms of glass vessels in which the working apparatus was enclosed. When he used the lower vacua, he was accustomed to employ a glass vessel, the mouth of which was closed by grinding the lip down even and then securing a glass plate thereto by the use of ce-

7093 ment. This enabled him to secure ready access, as he might desire, to the enclosed devices, since by softening the cement he could remove the plate. But when greatly higher vacua were to be employed, the cement joint was found inadequate, since the external air would leak through the joint; and therefore, when he desired to use an extremely high vacuum, he found it necessary to forego the advantage of ready access to the mechanism inside the globe, and seal up the vessel
7094 by fusion in such a manner that no joint would be left.

In section 83 of his paper read April 22, 1875, before the Royal Society, entitled "On Repulsion resulting from Radiation," and published in Part II, Volume 165 of the Philosophical Transactions of the Royal Society, he says:

"83. The cement which I have found best
" for keeping a vacuum is made by fusing to-
" gether 8 parts, by weight, of resin and 3 parts
7095 " of beeswax. For a few hours this seems
" perfect, but at the highest exhaustions it
" leaks in the course of a day or two. Ordin-
" ary or vulcanized india-rubber joints are of
" no use in these experiments, as when the
" vacuum is high they allow oxygenized air to
" pass through as quickly as the pump will
" take it out. Whenever possible the glass
" tubes should be united by fusion, and where
" this is impracticable mercury joints should
" be used."

7096 The practical application of this general principle is illustrated by him in various places in his papers read before the Royal Society; thus, in section 143 of another part of the same paper read before the Royal Society February 10, 1876, and published in Part II of Volume 166 of the Philosophical Transactions of the Royal Society, he shows a radiometer in which the exhausted bulb is closed by means of a flat plate of

ground glass cemented to the upper end of the bulb. 7097
In section 144, speaking of certain deficiencies in that particular apparatus he says, among other things:

" Also the cement joint rendered it impossi-
" ble to get the vacuum very good, whilst it
" took away from the permanant character of
" the instrument;"

and in the following section (145) he describes a modified form of the apparatus in which this particular deficiency is overcome by dispensing with the ground 7098
glass plate and *cement* union, and adopting a bulb in which the parts are *fused* together so as to leave no joint.

These two pieces of apparatus are illustrated in the sketches which I now produce, the same being taken from the official Transactions of the Royal Society, and enlarged on a scale of two to one.

Fig. 5

7099

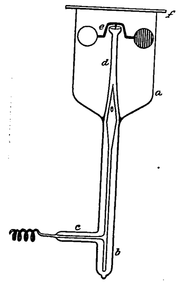

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Fig. 6

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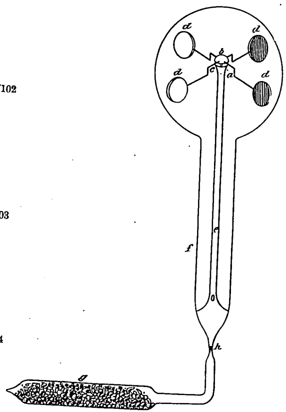


So, again, in sections 336 and 345 of "The Bakerian Lecture," read by Mr. Crookes, January 17,1878,before the Royal Society and published in Part I of the Philosophical Transactions of the society for the year 1878, he describes two other forms of radiometer in which an electric current is passed through the enclosing walls of the glass vessel for the purpose of heating a platinum wire to incandescence arranged within. In one of these pieces of apparatus (that described in section 336) the vessel is closed by a flat plate and cement, the description saying: 7105 7106

> "The top of the wide tube is ground and
> "polished quite flat and is covered by a piece
> "of plate glass, *g*, which can be cemented on
> "so as to form a perfectly tight joint,and may
> "be removed by warming so as to admit of
> "any experimental fly being supported on the
> "needle point."

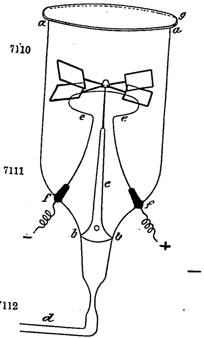
Substantially the same apparatus (with only a slight change as regards internal mechanism, but employing 7107
the fusion mode of closing the vessel) is shown and described in section 345. The description of this apparatus is as follows:

> "345. Fig. 31 represents the apparatus.
> "Instead of being open, and closed with a
> "plate cemented on, the cylinder is now
> "sealed at the top, so as to enable me to
> "proceed to the highest exhaustion, which
> "cannot be reached unless all the joints and
> "connections are fused together. The plati- 7102
> "num wire ring is shown at *a*, *a*, *a*, the slop-
> "ing mica vanes are shown at *b*, *b*. Above
> "the vanes is a flat disk of clear mica, *c*, *c*,
> "having a glass cap in its centre, and easily
> "rotating on a needle point. The vanes and
> "the mica disk are supported independently
> "of each other on separate needle points,
> "which are held in glass rods, *d*, *d*, *d*.

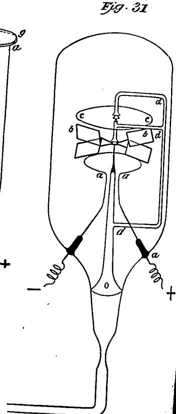
These constructions are illustrated in the following sketches taken from the Transactions of the Society.

Fig. 30 *Fig. 31*

7110



7111



7112

This use by Crookes of a glass vessel composed of 7113
two parts united by cement, or of a glass vessel in which the parts are joined by fusion, according to the character of the vacuum which he desired to secure and maintain, is but an illustration of what must for a long time have been perfectly familiar to all constructors of physical apparatus. In other words, it was perfectly well understood by all such persons, that if you desired to maintain in a glass vessel a vacuum so high that a mechanical or cement joint would be insuffi- 7114
cient, it was only necessary to dispense with such a joint, and resort to the ordinary process of uniting the parts of the glass composing the vessel by fusion, and thus eliminate all joints.

To my mind, therefore, it is perfectly evident that if a person making a Sawyer and Man lamp in which the globe was united to a glass base-plate by cement, should have found that the vacuum was not sufficiently enduring, he would, as a matter of course, if he had the slightest familiarity with the art, have pro- 7115
ceeded to close the lower end of his globe by fusion, in the same way precisely in which Crookes altered his two-part glass vessels when he desired to work with the higher exhaustions. There certainly would be no element of invention involved in doing this. This would be true not only of the year 1878 but long prior thereto.

39 Q. Are you familiar with the patent issued to Moses G. Farmer, March 25, 1879, No. 213,643 (granted 7116
on an application filed November 20, 1878)?

A. I am familiar with the patent to Moses G. Farmer referred to in the question.

40 Q. If in 1878 you had been called upon to make a lamp like that shown in the said Farmer patent, and on trial had found that it leaked at the base, would

7117 you have known how to correct such defect; and if so, how would you have proceeded to attain that result?

A. I should certainly have known how to correct this defect, since the universal practice which had for many years been observed with Geissler tubes, Crookes' tubes, and various devices of this sort, was perfectly familiar to me as to every one acquainted with physical apparatus.

If I had found that the Farmer lamp leaked at the
7118 base, I should have immediately proceeded to substitute for the elastic stopper through which the leading wires passed, a thin glass plug or thimble of suitable dimensions, into which I would have caused platinum leading wires to be fused, and this I would have connected by the ordinary process of fusion with the receiver of the lamp. In doing this I should have exercised no invention, since this was the commonest of processes when it was desired to maintain a vacuum within an enclosure. Indeed, in this mode of proceed-
7119 ure, I should only have been following out the explicit directions given by Mr. Crookes in relation to the construction of vacuum tubes in his papers on that subject, as published in the Transactions of the Royal Society, and referred to by me in my last answer; and, still further, in proceeding thus to remedy such imagined leakage with the Farmer lamp, I should have been employing the same process as that used by Mr. Edison in constructing his platinum lamp set forth in
7120 his U. S. Patent No. 227,229.

41 Q. If in 1878 you had been called upon to make a lamp like that shown in the Roberts patent of 1852, and on trial had found that it leaked at the base, would you have known how to correct such defect, and if so how would you have proceeded to attain that result?

A. I should have had no difficulty in knowing how to proceed to remedy leakage about the leading wires

of the Roberts lamp referred to in the question. I 7121
should have substituted for the metallic cap specifically described by Roberts, a construction similar to that to which I have referred in my last answer.

42 Q. Professor Barker in answer to question 5 in his deposition in this suit, assumes that Mr. Edison, by the invention set forth in the patent in suit, effected what he calls a "new departure" in the art of incandescent lighting, which presents four features that 7122
he enumerates as "features of importance." The first of these is that "the carbon burner has a small cross-"section and presents a small radiating surface even "when given considerable length."

Please state whether this alleged improvement in incandescent lamps was new with Mr. Edison.

A. In my opinion this was not new with Mr. Edison. The use in an incandescent lamp of a burner having a small cross-section and small radiating surface, even 7123
though of considerable length, was no new departure with Mr. Edison, whatever the incandescing material which he saw fit to employ as a burner.

The value of this principle in the construction of an incandescent lamp, is evidently entirely independent of the material of the burner. This principle had been recognized and employed with platinum wires ever since the fact was first known that platinum could be heated to incandescence by electricity. It had also been recognized in the case of incandescent lamps, as
for example, in the platinum lamp of King's British pa- 7124
tent No. 10,919 of 1845, and in Edison's U. S. Patent No. 227,229, in which last document the advantages of such a construction of burner are specifically pointed out; and also in the British patents of Lane-Fox.

So far is the mere use of this principle in a lamp with carbon as the material of its burner from being

7125 a new departure, that in my opinion this would not involve the slightest trace of invention. But the application of the principle in question to incandescent lamps with carbon burners was by no means new with Mr. Edison. The carbon lamps of King, Roberts and Lane-Fox, as set forth in their patents already referred to in my previous answers, possess carbon burners whose cross-section is small, and the desirability of this construction is insisted upon in these patents; the
7126 patents of Lane-Fox already referred to, especially, containing explicit statements as to the principles governing the dimensions of such burners.

Still further, carbon burners of small cross-section and with small radiating surface had been employed in incandescent lamps which used Carré carbons of only a millimetre cross-section.

For these reasons I do not consider that the alleged improvement referred to by Professor Barker was in any way new with Mr. Edison.
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43 Q. Another alleged "feature of importance" which Professor Barker enumerates when he credits Edison with having made "a new departure" is stated by him as follows:

> "The filamentary burner is made of a peculiar kind of carbon, i. e., one produced by the carbonization of a material, the volatile portions of which pass off during the carbonization, leaving a porous carbon residue."

7128

Was this new with Mr. Edison?

A. It was not. Of course the peculiarity of the carbon referred to by Professor Barker, namely, that it is "produced by the carbonization of a material, the volatile portions of which pass off during the carbonization, leaving a porous carbon residue," resides in all carbon which is made by the ordinary processes of

carbonization, being characteristic, for example, of ordinary charcoal. Moreover, various processes of producing porous carbon in the form of fine wires by carbonization had been described and set forth; for example, those of Gauduin, Sidot, Carré and others. The process of constructing his burner, given by Mr. Edison, is substantially the same as that described by Thomas F. Scott in British patent No. 861 of 1878, and by Pulvermacher in British Patent No. 4,774 of 1878. Such porous carbon as is referred to by Professor Barker was also used, as I understand to be shown by the evidence in this suit, by Messrs. Sawyer and Man in their various lamps made in 1878 and 1879. 7129 7130

If Professor Barker means by the words, "a peculiar kind of carbon," a carbon having a porosity which results from carbonization, unchanged by any additional treatment, I cannot see why Carré's process would not be an answer. But even if it were not, and it were to be admitted that such a process was new with Edison, I do not see how this could be regarded as a 7131
"feature of importance;" because, as I understand it, the attempt to preserve the high porosity that results from simple carbonization alone, is attended with such disadvantages—such as lack of uniformity, too great brittleness, lack of strength, etc.—that on the whole it has been found necessary by all manufacturers so far as I know, except the Edison company, to reduce the porosity by hydro-carbon treatment, even although it lowers the specific resistance very considerably.

Mr. Edison, as I understand, overcame these difficul- 7132
ties in great measure without reducing the porosity, and the consequent high specific resistance of the carbon, by the use of bamboo as a material, and by great refinements in the processes of carbonization used by him in the manufacture of his burners, some of which are described in his subsequent patents, and some of which, as I understand from his testimony in the case of the Royal Electric Company of Canada, against

7133 the present complainant, are of so delicate and difficult a nature that the proper conditions to be observed in carrying them out cannot even be formulated in words, and are so difficult to teach to others that at times even his best assistants have been unable to carry on the processes commercially with any success.

I quote from Mr. Edison's testimony in the Canadian case above referred to as found on page 144 of the printed record, as follows:

7134
"The carbon filaments of my lamp are a "pure vegetable carbon, made by the carboni-"zation of cane bamboo and without the "addition by deposit of any mineral carbon.

"My lamp factory at Harrison, New Jer-"sey, I believe to be the only factory making "a carbon of this character, and I consider "the success and reputation of my lamp from
7135 "a commercial point of view to be largely de-"pendent upon the fact that I use such a car-"bon. Other manufacturers of incandescent "electric lamps find it necessary to build up "their carbons and cure their defects by de-"positing upon them a layer of mineral car-"bon obtained by dipping the carbons, when "in the condition that they are in when re-"ceived from the furnaces, in a hydro-carbon "liquid, and then, while they are immersed "in the hydro-carbon liquid, passing an
7136 "electric current through them, which decom-"poses the hydro-carbon and deposits a "layer of mineral carbon upon the filaments.

"By long experience and the most careful "and exhaustive investigations, I have been "able to bring the process of preliminary "carbonization in furnaces to such a state "of perfection that a sufficiently large per-"centage of good carbons is obtained from "the furnaces to enable me to make lamps

"having the pure vegetable carbons, which 7137
"need no mineral deposit to make them use-"ful and only require the process of final car-"bonization to perfect them for use. In "order to make carbons of this character, "however, the process of preliminary carboni-"zation has to be conducted with great skill. "The process is entirely dependent upon "judgment as to proper heat at different "stages, and how long to maintain them, 7138
"which conditions in turn are dependent "upon and vary with conditions which can-"not be stated, but can only become known "to a person from long experience. It can-"not be told whether the carbons are good or "bad before they are taken out of the fur-"naces and tested. We have lost many "large lots of carbons in carbonization, and "at times we have entirely lost the art of "carbonization, due to some failure in mat- 7139
"ters of detail which we could not discover. "The commercial process is a most illusive "one. We have at times carried on the pro-"cess concurrently with regular observations "as to the various atmospheric conditions of "temperature, moisture, pressure and direc-"tion and velocity of wind, thinking that we "might discover that the exact process was "dependent upon some particular atmos-"pheric condition. When we moved our 7140
"lamp factory from Menlo Park to Harrison, "New Jersey, and although I gave the matter "considerable personal attention, it was some "time before we succeeded in making good "carbons at Harrison.

"The Company at Paris, which acquired "my patents for the Continent of Europe, "established a large lamp factory in France

7141 "under the management of Mr. Charles
"Batchelor, the man who acted as my princi-
"pal assistant throughout my experiments on
"the subject of electric lighting, and yet by
"reason of failure in carbonization, due to
"some slight but unknown difference in con-
"ditions, the lamps made in France for some
"time were commercially a failure. An enor-
7142 "mous amount of money was spent by that
"company in its attempts to establish the art
"of carbonizing pure vegetable carbons, but,
"after almost bankrupting the company by
"the expense, they were forced to resort to
"the hydro-carbon treatment in order to make
"a lamp at all commercial, and the lamps
"made by that company to the present time
"have the treated carbons.

"In the fall of 1886, complaints having
7143 "been made that the lamps manufactured at
"the factory at Harrison, New Jersey, had
"greatly depreciated in quality, I found it
"necessary to undertake personally the rem-
"edying of the difficulty. I moved my labor-
"atory force and apparatus to the lamp fac-
"tory, and for about a year continued my
"investigations and experiments on the sub-
"ject of carbonization. At first I could find
"no reason for the depreciation in the qual-
7144 "ity of the lamps, but by investigation it
"finally appeared that some slight but there-
"tofore unnoticed changes had been made in
"the carbonization, and by going back to a
"strict observation of our former practices
"the difficulty was remedied.

"The company located at Berlin, Germany,
"which purchased the patents on my lamp
"for Germany from the company located at

7145

"Paris, established a large lamp factory
"under the direction of Mr. James Hipple,
"who went from my lamp factory in this
"country, and was a man of large experience
"in lamp manufacturing methods. Furnaces
"were set up, and an attempt made to manu-
"facture lamps having pure vegetable car-
"bons, but the same difficulties were experi-
"enced as had been experienced by the
"French company, and the lamps were a
"complete failure from a commercial point of 7146
"view. The German company was obliged
"to resort to the hydro-carbon treatment of
"the carbon filaments, notwithstanding the
"fact that they employed the best obtainable
"talent and expended a large amount of
"money in endeavoring to make pure vege-
"table carbons. The lamps made by that
"company are to this day provided with
"carbons having the mineral deposit pro-
"duced by the hydro-carbon treatment. 7147

"Our experience has shown us that had
"we persisted in our endeavor to carbonize
"pure vegetable carbons in Canada, it would
"have been necessary, in order to make it
"successful, for me to go personally to Can-
"ada with the carbonizing force of our United
"States factory, and to stay there fostering
"the process, which would have resulted in
"the serious crippling of our lamp manufac-
"turing business in the United States." 7148

This testimony appears to have been given in November, 1888.

44 Q. Still another alleged "feature of importance" which Professor Barker enumerates when he credits Mr. Edison with having made "a new departure," is stated by him in the following words:

7149

"The filamentary burner is made by first reducing the material to the size required, or selecting a material in the proper form and then carbonizing it."

State whether it was new with Mr. Edison to shape carbons for lamps, either arc or incandescent, before carbonization?

A. It was not new with Mr. Edison to do this. For example, Sawyer and Man proceeded thus in the con-
7150 struction of their incandescent burners, as is shown by the evidence in this suit. The same is true of the methods used by Carré in making carbons for incandescent lighting. The same process was almost universally employed in the manufacture of carbons for arc lighting and similar purposes by Carré, Gaudoin, Pulvermacher and others. These processes will be found described in Defendant's Exhibit, Chapter 3 of Fontaine's work on Electric Lighting relating to the manufacture of carbon. It was very seldom that the
7151 burners were cut out from blocks of gas retort carbon.

45 Q. A fourth alleged "feature of importance" which Professor Barker enumerates when he credits Mr. Edison with having made a "new departure," is stated by him as follows:

"An exhausted and sealed glass bulb is em-
"ployed to contain the burner, which bulb,
"as we afterwards see, is made of an entire
7152 "piece of glass closed at all points by the fu-
"sion of the glass and capable of maintain-
"a vacuum, as distinguished from the separ-
"able lamps with cemented joints before em-
"ployed."

Please state whether in this regard Mr. Edison, in your judgment, made any "new departure" in this art?

7153

A. In my judgment he did not. Thus, the alternative form of the King lamp set forth in British patent No. 10,919 of 1845 would have been made in this way; and the platinum lamp described by Mr. Edison in his United States patent 227,229 has the same structure. The same is also true of certain of the different forms of radiometers constructed by Mr. Crookes; as also of the Geissler-tube lamps made for the illumination of mines, for subaqueous work and for surgical purposes. 7154

46 Q. In answer to question 5, Professor Barker has also enumerated various advantages which he asserts result from the use of a burner having a small cross-section. These advantages, as I understand his testimony, are:

1. That wires of platinum can be used small enough to be readily sealed into the glass, and yet sufficiently large to carry the required current without heating to an extent that will in- 7155
jure the seal.

2. A small radiating surface and a high resistance per unit of radiating surface.

3. The securing of an effective electric contact between the leading-in wires and the burner.

4. A diminution in the amount of heat which with a large burner would be conducted back to the seal of the leading-in wires.

Please state whether he thus enumerates any advan- 7156
tages that did not characterize the older carbons known to the art of incandescent lighting?

A. I do not see that there are any of the advantages thus asserted by Professor Barker which were not true of the older carbons used in incandescent lighting.

Previous to the date of the Edison patent, incandescent lamps had been constructed having carbons of

7157
only one millimetre in cross-section; and it is well known that wires of platinum sufficient to carry the required current to bring such a carbon to incandescence, can readily be sealed into the glass, so as to give a permanent seal. Moreover, in King's British patent, already referred to, the patentee specifically states that he proposes to use platinum as one of the leading-in wires with his barometer glass, sealing it into the glass precisely in the manner referred to by Professor Barker.

7158 As regards a small radiating surface and a high resistance per unit of radiating surface, mentioned by Professor Barker as an advantage, I do not see why this was not found in earlier incandescent lamps; as, for example, in those which made use of the small Carré carbons, as well as in those of King and Roberts, assuming their directions as to the smallness of section of the conductor to be carried out.

As to securing an effective electric contact between the burner and the wires, also mentioned by Professor
7159 Barker as an advantage incident to smallness of cross-section, I cannot see how reduction in the size of the old burners, such, for example, as those of King, or Roberts, or Sawyer and Man, will make any appreciable difference in this respect. I do not understand that there is any more difficulty in making a good union with carbons having a diameter of one millimetre than with carbons very much smaller.

Nor do I think that there is any evidence that the older carbons used in the art would have given out
7160 such an amount of heat as to injure the seal of the leading-in wires.

For these reasons it seems to me that the characteristics referred to by Professor Barker were found in various of the carbons already known in the art.

47 Q. I find in Professor Barker's testimony, in answer to question 5, this statement:

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"Another characteristic resulting from the "filamentary form of the burner"—by which I understand him to mean small cross-section—"is that of elasticity and flexibility, in virtue "of which the burner can be attached to the "terminals rigidly fixed in position, and this "without endangering the integrity of the "filament from shock or expansion."

Please state whether you find in the patent in suit any warrant for this statement? 7162

A. I have examined the patent carefully, and do not find in it the slightest warrant for Professor Barker's statement referred to in the question.

I may add that I do not understand that flexibility is necessarily a desirable quality in the burner of an incandescent lamp. Assuming the burner to have been once brought into the shape which it is to retain in use, it seems to me that the qualities most essential 7163
then are rigidity and strength and not flexibility.

As to elasticity, it is of course desirable that the burner shall be sufficiently elastic to restore itself to its normal position when by any shock it is forced therefrom; but I do not understand that a burner of excessively small cross-section is necessarily any more elastic than if its size were larger.

48 Q. Please state whether the various advantages which Professor Barker enumerates as resulting from 7164
the use of a burner having a small cross-section do not characterize the burners of the Bernstein lamps, the Edison Municipal lamps and the Thomson-Houston series lamps?

A. The various advantages referred to in the question undoubtedly do characterize the burners of the Bernstein lamps, the Edison Municipal lamps and the

7165 Thomson-Houston series lamps, except that on account of the short length of the burners in these several lamps, they possess but little flexibility; but, as I have said in my last answer, I do not deem this a matter of moment, and certainly not one referred to in Mr. Edison's patent.

49 Q. Professor Barker, in answer to question 6 in
7166 this case, has said that:

> "As a contribution to the art of electric "lighting I attribute the greatest importance "to the invention of the patent in suit; in-"deed, in my judgment, it is not too much to "say that this invention was practically the "creation of a new art in lighting by elec-"tricity."

Do you agree with Professor Barker in this view of
7167 the importance of the alleged invention covered by the patent in suit, and if not, please state the grounds of your disagreement?

A. I do not agree with Professor Barker in the opinion expressed by him as quoted. On the contrary, as I understand the contents of the patent, the contribution which it makes to the art of incandescent lighting is quite insignificant; but, even taking the construction of the patent contended for by Professor Barker, it seems to me very clear that the modern art
7168 of incandescent lighting has been created, not by this or any other invention alone, but by many contributions made by different inventors, some of which I consider fully as important as this.

As I understand it, the practical success and large commercial introduction of the art of incandescent lighting, as well as that of arc lighting, was due to the great impulse in the application of electricity to various useful arts which commenced some two or

7169

three years prior to 1880, and has continued with increasing force down to the present time.

Prior to the appearance of the telephone in 1876 very little use was made of electricity in the arts except in telegraphy and signalling systems and in electro-plating, although the general principles of electrical science were quite well understood and the arc light had been used to a very limited extent in European light-houses.

The commercial success of the telephone apparently 7170
gave a great stimulus to the work of experimenters in other applications of electricity, and, commencing about the year 1878, the extent and variety of the uses of electricity in the arts have increased with very great rapidity. Arc lighting, incandescent lighting, electrical transmission of power (notably for the propulsion of street cars, electric smelting, electrical refining of metals, electric welding and various other very important applications of electricity, have, commercially speaking, come into existence since the year 7171
1878, and the practical use of electricity in the arts is still extending rapidly.

So far as electric lighting is concerned, a very great impulse was given to the art by the successful lighting of some of the streets and public places at Paris by the Jablochkoff system in 1878, and also by the widespread attention attracted to the subject by the various sensational articles in regard to Mr. Edison's work which appeared during the latter part of that year and the early part of the following year, and which work, 7172
as I understand it, did not involve the invention to which the patent in suit relates. A great number of inventors and engineers in all parts of the world turned their attention to the subject, and the result has been a vast number of inventions and improvements in these and the allied arts (such as steam engineering and the manufacture of insulated wires, cables and

7173 other necessary materials), which have in the aggregate rendered both the arc and the incandescent systems commercially practicable.

As it seems to me, the growth of the incandescent system has been in all respects parallel to that of the arc system, and the causes which have led to commercial success have been the same in both cases.

Prior to the latter part of 1878 there was substantially no commercial business of arc lighting, although,
7174 as I have already said, the arc light had been employed in light-houses in a few instances, and perhaps in a very few cases and to a very limited extent for other practical uses. Although arc-lighting has since that time developed into a great industry, employing vast amounts of capital and great numbers of workmen, I do not think it is possible to point to any one invention as having produced this result, but, on the contrary, I think it is generally conceded to have been due to a great number of improvements contributed by
7175 various persons, which have in the aggregate been of very great importance.

The same thing is, as I understand the history of the art, true of the incandescent system.

Thus, to consider only a portion of the various inventions, improvements and developments, which have been necessary to the general introduction of incandescent lighting, it is to be observed, in the first place, that very material improvements in the dynamo machine had to be effected before it could be practically employed
7176 for the economical generation of electricity on the large scale necessary for central-station incandescent lighting.

Although the principle of the dynamo machine had been invented as early as 1868, substantially no practical use of it was made until after the invention of the Gramme type of machine about 1870; and even the

Gramme machine was not generally known or practi- 7177
cally employed, except, perhaps, for electroplating, until a number of years later. As originally constructed it was not in any way suitable for incandescent lighting, even upon a small scale; so that the dynamo machine itself had to be modified, improved and remodelled before it could be of any practical use as a source of electricity for incandescent lighting on a large scale. The earlier machines were unsteady, giving a current subject to large fluctuations; they were 7178
expensive to construct, very liable to get out of order and extremely inefficient so far as commercial purposes were concerned, since almost half of the energy produced by them was wasted in uselessly heating the machine. Successive improvements were made, some of them involving important inventions, others involving scarcely less important changes of form or structure, and thereby, by a gradual process of evolution, the dynamo machine was brought to its present high state of perfection. 7179

The invention of the drum armature, the lamination of the core of the armature, the remodelling of the relative proportions of the different parts of the machine so as to give a closed magnetic circuit, the use of an armature of very small internal resistance which should nevertheless give a sufficiently high electromotive force, the adoption of new methods of winding the drum armature, the invention of practically-available methods regulating the strength of the current furnished by the machine, important details in the form and construc- 7180
tion of the commutator and brushes—all of these were essential to the construction of a machine that would be practically useful.

Besides this, it is to be remembered that the construction of the machines themselves in large numbers, made necessary the invention of multifarious devices for facilitating the construction of the various parts,

7181 while special machines had to be invented and built to do this work with suitable rapidity, uniformity and exactness.

I may also note in passing, the fact that many recent improvements in steam engines have contributed very largely to the availability of electricity as a source of illumination, since in the early days of electric lighting a great source of difficulty was found in the unsteadiness of such types of engine as were then available and the high cost of producing the power.
7182 Improvements in the manufacture and insulation of wire, used in constructing the machine, have also contributed largely to success in making proper dynamos.

Still further, in the means used for distributing electricity, a large number of devices have had to be superadded to the multiple-arc system in order practically and economically to make use of central-station incandescent lighting. The introduction of feeders and inter-connected mains and of the three-wire system, together with pressure regulators and indicators,
7183 as well as the use of suitable meters, have been of great importance, and some of these have been indispensable to the commercial introduction of the direct multiple-arc system of distribution in central-station lighting.

In addition to this, a very important contribution has been made to the art within the past few years, known as the transformer or converter system of distribution, which has enormously extended the field available for incandescent lighting. This system
7184 consists, briefly stated, in the use of devices called "transformers" or "converters" for reducing the pressure, so that the current can be conveyed at very high pressures and on small wires to the neighborhood of the lights and there reduced to the comparatively low pressures required for working the lights. The introduction of this system has of itself given a very

great impetus to central-station lighting. This system, 7185
as I understand, is used at the present time for central-station work by all the companies in this country except the Edison Company, and the Edison Company itself is making use of the three-wire or multiple-wire system which was not introduced until some two or three years subsequent to the date of the patent in suit. Without this it would have been, in my opinion, impossible for the Edison Company to have made anything like the progress in central-station lighting which it has made. 7186

Still further, a vast number of devices necessary to be used in connection with an electric lighting system had to be invented or constructed, such as underground conductors with suitable insulation, junction-boxes, connecting pieces, a great variety of fittings and fixtures for wiring, fixtures, sockets and holders for supporting the lamps, safety devices, switches and the like.

Coming now to the lamp itself, a great number of other inventions besides that which, even upon the interpretation given by Dr. Barker, is to be found in the 7187
patent in suit, have contributed largely to the success of the modern incandescent lamp, and some of these have been of the most vital importance.

The process of expelling occluded gases from the carbon, described in the patent of Sawyer and Man No. 210,809, is in my opinion essential for the construction of a practical lamp, and is in fact, as I understand it, universally used by all manufacturers. The process of hydro-carbon treatment described in the patent of Saw- 7188
yer and Man No. 211,262, was also a very important contribution to the art, and is, in fact, used, as I understand it, by all manufacturers at the present time except the Edison Company, and the latter company is, as I understand it, enabled to dispense with this process only by the use of special processes of carbonization

7189 and treatment invented by Mr. Edison since the date of the patent in suit.

Among contributions to the art shortly subsequent to the date of the patent, I may mention the improvements in the process of hydro-carbon treatment introduced by Mr. Maxim and the application of this process to standardizing the resistances of the carbons; the improved processes of carbonization above referred to as introduced by Mr. Edison; and the introduction of new materials and new processes and devices for
7190 shaping and preparing them before carbonization. In addition to these, there have been a vast number of improvements in details, such as the construction of the globe, attachment of the carbon to the leading-in wires, improvements in mercurial air pumps, etc.

That Professor Barker has placed a grossly exaggerated estimate upon the value of the alleged invention covered by the patent in suit, is conclusively shown, as it seems to me, by the statements of the Edison Company
7191 itself. Thus in its official Bulletin No. 21, it refers to *three* of Mr. Edison's patents relating to incandescent lamps as being "fundamental." A reference to one of these patents, to wit, No. 227,229, shows that it has a claim which is broader than any claim of the patent in suit, even as such patent is interpreted by Professor Barker. Moreover the Edison Company in the said Bulletin states that, in addition to the said three fundamental patents.

7192 "Mr. Edison holds 83 other patents already "granted in this country on the lamp alone, "and has applications for 75 more patents on "the lamp alone now awaiting decision."

And further on in the same bulletin the company says that:

"These patents allowed to Mr. Edison on "his lamp are only a small portion of the

"patents allowed to him in connection with 7193
"the use of the lamp. Up to the present "time no less than 227 patents have been "allowed to Mr. Edison in the United States "alone on his lamp and on the details connected with its manufacture and use, and "he also has 179 additional applications for "patents on the same subject now awaiting "examination at the Patent Office."

This bulletin was issued in December of the year 7194
1883.

Mr. Edison's views, as expressed in his testimony in the McKeesport suit already referred to, are also widely at variance with the statements made by Professor Barker. I quote from Mr. Edison's deposition, beginning on page 285 of the printed record in the McKeesport case (italics mine) as follows:

"The problem then that I undertook to solve "was, stated generally, the production of the
"multifarious apparatus, methods and devices, 7195
"each adapted for use with every other "and all forming a comprehensive system "whereby electricity, properly controlled and "directed, could be distributed over large "areas through the streets of a city, and "supplied to houses in which it would feed "incandescent electric lamps of moderate candle power, which would be entirely under
"the control of the householder, *the whole to be* 7196
"*on the same scale as the present system of gas "distribution and affording the same character "of convenience to the users.*

"The first thing necessary to be done was "to adopt a fundamental, correct system "of distributing the electric current, and "then to devise *a lamp which could be worked*

7197

"*practically on such a system*—that would be
" practical and satisfactory both in a commer-
" cial and scientific sense. The essentials of
" *a comprehensive system of electric illumina-*
" *tion similar to the general plan of illumi-*
" *nation by gas*, were a net-work of conduc-
" tors all connected together, so that in a city
" area the lights could be fed with electricity
" from several directions, thus eliminating
7198 " the disturbances to any particular section.
"Second. To devise an electric lamp which
" would give about the same amount of light
" as the gas jet, which custom has proved was
" a suitable and useful unit, and which should
" possess the qualities necessitated by small
" investment in the copper conductors. It
" was also necessary that each lamp should
" be independent of every other lamp, although
" on the same circuit. *That the light should*
7199 " *be produced sufficiently economically to com-*
" *mercially compete with gas.* That the lamp
" should be durable, and capable of being
" handled by the public, and cheap to manu-
" facture, and one that would remain incan-
" descent and stable a great length of time.
"Third. It was also necessary to devise
" means whereby the amount of light fur-
" nished a consumer could be accurately
" determined, as in the case of a gas-meter,
7200 " and that this should be done cheaply and
" reliably.
"Fourth. I had also to devise a system of
" conductors capable of being placed under-
" ground or overhead, and which would allow
" of being tapped at intervals, speaking gen-
" erally, about the width of each house facing
" the street, so that service wires could be

7201

" run from the main conductor into each
" house, as gas pipes run from gas mains,
" and generally whatever was necessary to such
" a comprehensive system of distribution as
" the system I had in view required. Where
" the conductors were to be placed under-
" ground, which I contemplated doing in large
" cities, it was necessary to devise a system of
" protective pipes for the copper conductors,
" which would allow of their being tapped 7202
" wherever required; also manholes, junction
" boxes, connections, and the various para-
" phernalia of a complete system for under-
" ground general distribution.
"Fifth. I had also to devise means of pro-
" ducing at all points, and on an extended
" area of distribution, a practically even pres-
" sure analogous to gas, so that all of the
" lights should give an equal light at all times
" and independent of the number that might 7203
" be in use. I had also to devise means for
" regulating, at the point where the current
" was generated, the equality of the pressure
" of the current throughout the whole light-
" ing area, also a means of indicating what
" the pressure was at the various points of
" the area.
"Sixth. I had also to devise economical
" dynamo machines for the conversion of
" steam power into electricity; means for con- 7204
" necting, disconnecting, working and regu-
" lating the same; means for equalizing their
" loads; means for regulating the number of
" machines to be used, to the demands on the
" station for electricity from the users of the
" light. The arranging of complete stations,
" with steam power and electric apparatus,

7205 "and devices of all kinds to suit the varying
"conditions of buildings available for such
"stations in cities.

"Seventh. I had also to devise devices
"which would prevent the current used from
"becoming excessive upon any conductors, and
"causing fire or other injury, switches where-
"by the current could be turned on or off at
"such points as it was desirable that this
"should be done, lampholders, electric chan-
7206 "deliers and the like. I had also to devise
"means and methods for placing the wires
"that were to convey the current to the chan-
"deliers in buildings."

Mr. Edison is here referring only to the system used by the Edison Company, and when we consider also the systems used by the other companies, the multitude of additional devices necessary for success becomes greatly increased, especially when we take into
7207 account the transformer systems working on widely divergent lines from the direct multiple-arc system adopted by Mr. Edison.

In view of these facts it seems to me that the patent in suit, cannot under any interpretation of it, fairly be said to have created any new art.

50 Q. In view of the various inventions and classes of inventions enumerated by you in your last answer as connected with incandescent lighting, I will ask you
7208 what chance of commercial success a lamp like that which is shown and described in the Edison patent in suit would have had if it had been patented, say, in the year 1845?

A. In my opinion it would have had no chance of commercial success at that date, nor long subsequent to it. The time was altogether too early to enable such a device to be utilized; the great number of various

elements which I have shown to be requisite for 7209
practical success with any incandescent lamp had yet to be devised, and, indeed, a host of conditions for the general introduction of such a lamp had yet to be worked out.

51 Q. You have stated in answer to question 20 that at least two of defendant's lamps (to wit, the zig-zag paper lamp and the M lamp) are not adapted for
extended use in multiple-arc in a general system of 7210
electric lighting, with any mode of electrical distribution known to the art at the date of the patent in suit. Is it a fact, however, that these lamps are capable of wide use, in the manner indicated, with systems of electrical distribution that have since become known; and if so, briefly explain how?

A. It is a fact that these lamps are capable of extensive use for the purposes of general illumination when used in connection with the converter or transformer system
to which I have referred in my answer to interroga- 7211
tory 49. This system has come into use since the date of the Edison patent, and was not known to the art at that time. In it, however, only a comparatively small number of lamps are placed in parallel with each other, and run from a single transformer. The number that are fed from a single transformer usually is not more than 40 or 80. Of course a large number of these transformers may be, and in practice are, actuated by the current supplied by a single dynamo at
the central station, and in a sense, therefore—but not 7212
in any sense in which the words could have been understood at the date of the Edison patent—it may be said that large numbers of these lamps of comparatively low resistance are operated from a single station; but it should be remembered that with the converter system the electrical current which actually feeds the lamps is not the current which comes from the central

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station through the main conducting wires, but that such current serves simply to actuate the several converters or transformers, and that each converter or transformer is a separate generator of current which feeds only the small number of lamps that are directly connected therewith.

52 Q. One of defendant's three lamps in evidence in this case uses as its burner the material known as tam-
7214 adine. Please state, if you know, whether this material was known to the arts at the date of the Edison patent in suit?

A. My understanding of this matter always has been that this material, tamadine, was invented by Mr. Weston at a date at least one or two years subsequent to the date of the Edison patent. It was patented to Mr. Weston in United States patents No. 264,986 and No. 264,988, bearing date September 26, 1882. Its employment by the United States Electric Lighting Co.
7215 as the material for the burners of their incandescent lamps was the practical introduction of a material at the time wholly new to the arts.

53 Q. According to the testimony of Prof. Barker, the virtue of the alleged invention covered by the patent in suit depends largely upon the assumed difference in size (cross-section) between the carbon "rods" of the older incandescent lamps and the carbon "wire," (also spoken of incidentally as "filament") of the lamp of the patent. Admitting for present purposes that
7216 this assumed difference between the old and the new lamps actually exists, how far, in your opinion, did this change in the mere size of the carbon burner (whatever may have been the extent of such change) involve invention, as distinguished from the logical application of the well-known laws of electrical engineering to the special problem contemplated by the patent?

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A. I fail to see that there was any invention, or any room for invention, in the passage from the older lamps, with their carbons of assumed comparatively large cross-section and low resistance, to a lamp having a burner of smaller cross-section and higher resistance. The adaptation of incandescent lamps to different conditions of current and circuit, by changing the cross-section and length of the burner, involved only the application of fundamental principles of electricity; and these principles were well understood and distinctly 7218
recognized prior to the date of the Edison patent under consideration—not only in their application to translating devices generally, but in their special application to incandescent lamps, as I have already indicated in my answers to questions 23, 24, 25, 26, 34, and 37.

54 Q. You have referred in one of your answers to one of the official Bulletins of the Edison Electric Light Co. What were these Bulletins? 7219

A. The Bulletins in question are printed publications, and were issued from time to time by the Edison company as a means of giving information to their agents, and the stockholders of the company, and through them I suppose to the public generally, as to the progress of the work of the Edison company in electric lighting. They were quite generally distributed not only to thosewho were immediately connected with the Edison company, but also among scientific and professional men who presumably might desire to 7220
know something of the work in which the company was engaged. I have a full set of these Bulletins, and the library of the Physical Department of the Massachusetts Institute of Technology has another, both furnished by the courtesy of the Edison Co.

55 Q. In your answer to question 6 you have referred to various forms of Geissler tubes as being incandes-

7221 cent lamps. How long have you known of the existence of lamps of this description?

A. I do not recollect precisely when I first became acquainted with them, but it was certainly as long ago as 1867 or 1868. I have had both the surgical lamp and the submarine lamp in my possession, among the apparatus at the Institute of Technology, ever since I began to teach there, over nineteen years ago, and I have frequently shown them to my classes. I am aware
7222 of an early description of such a lamp which is given in the Proceedings of the Royal Society for March 29, 1869 (Vol. 10, page 432). The article is written by Mr. Gassiot, widely known as a physicist, who had made the phenomena observed when electricity is passed through vacuous spaces a subject of extended and minute study.

The article in question reads as follows:

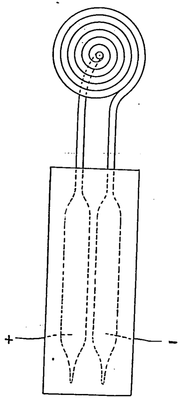
"IV. On the Application of Electrical Dis-
7223 "charges from the Induction Coil to the "Purposes of Illumination. By J. P. Gassiot, Esq., F. R. S. Received March 29, 1860.

"The subjoined figure represents a car"bonic acid vacuum-tube of about 1-16th of "an inch internal diameter, wound in the "form of a flattened spiral. The wide ends "of the tube, in which the platinum wires are "sealed, are 2 inches in length and about ½ of "an inch in diameter, and are shown by the
7224 "dotted lines; they are enclosed in a wooden "case (indicated by the surrounding entire "line), so as to permit only the spiral to be "exposed.

"When the discharge from a Ruhmkorff's "induction apparatus is passed through the "vacuum-tube, the spiral becomes intensely "luminous, exhibiting a brilliant white light.

"Mr. Gassiot who exhibited the experiment

"at the meeting of the Society, caused the "same discharge from the induction coil to pass "through two miles of copper wire; with the "same coil excited so as to give a spark through "air of one inch in length, he ascertained that "the luminosity in the spiral was not reduced "when the discharge passed through 14 miles "of No. 32 copper wire." 7225



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7229 The cut as here given shows an apparatus of the dimensions stated in the description, but twice the size of the original cut, which, as I understand it, was only one-half size.

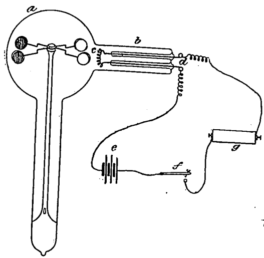
56 Q. You have heretofore referred to the papers of Mr. Crookes on radiometers and allied matters, as published in the Philosophical Transactions of the Royal Society. State whether you are familiar with the
7230 papers thus referred to, and particularly with the radiometers therein described?

A. I am. I have been acquainted with them ever since they were published, and have had occasion to use many of the different forms of radiometer described therein.

57 Q. State whether you find described in said papers any form of radiometer which embodies in its organization an incandescent electric lamp?
7331 A. I find described in these papers several pieces of apparatus whose organization in all essential particulars constitutes them electric lamps. They contain a wire in the shape of a coil or loop, which is rendered incandescent by the passage of a current of electricity, with the intention of effecting the illumination of certain objects by this means. They were not intended by Mr. Crookes to be used for purposes of general illumination, but they were made incandescent in order that the rays issuing from them might illum-
7232 inate certain objects which he desired to subject to the influence of light thus produced.

An apparatus of this kind is found described in a paper read by Mr. Crookes before the Royal Society on February 10, 1876, and published in the Philosophical Transactions, Volume 166, Part II, page 351. The apparatus is shown in Figure 10 on this page. The following is a copy of the sketch of said apparatus as taken from the Philosophical Transactions, being enlarged on a scale of two to one:

Fig. 10 7233



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The same apparatus is also described on page 226 of *Nature*, published at London, January 11, 1877:

The instrument and its use is described in Crookes' paper as follows:

> "Fig. 10 shows the instrument; *a* is the "bulb of a radiometer of the usual construc-"tion, having pith disks blacked on one side; 7236
> "*b* is a tube sealed into one side of the bulb, "and having two stout platinum wires pass-"ing along it sealed their whole length in "glass to prevent leakage of air into the "interior of the apparatus. At the ends, *c*, "of the wires, a spiral of fine platinum wire "is fastened, and the other ends (*d*) terminate "in loops outside; *e* is a battery, *f* a contact-"key, and *g* a resistance coil which I can "vary at will. The bulb was perfectly ex-"hausted and the following experiments were "tried:

7237 "176. The resistance coil was so adjusted "that the battery would keep the platinum "spiral *c* at a bright red heat. The arms of "the radiometer, which were before quite still, "moved rapidly until two of the disks were "one on each side of the hot spiral, the black "disk being further off than the white disk "as shown at *i*. The resistance was then

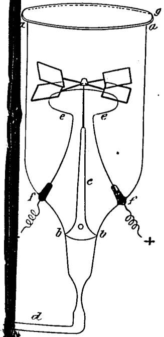
7238 "gradually increased, and as the temperature "of the spiral diminished, the black disk "gradually approached the spiral, until when "the temperature was just at the point of "visible redness in a dark room, the black "and white disks were practically equi-dis- "tant from the spiral. On diminishing the "resistance, the same phenomena took place "in inverse order.

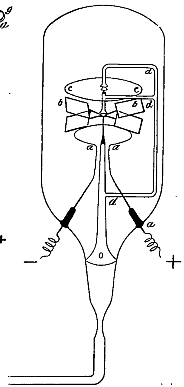
7239 "177. The resistance was adjusted to give "a bright red spiral and the contact-key kept "pressed down. The disks stood as at *i*. A "lighted match was momentarily brought "near the bulb so as to start a movement, rota- "tion of the arms commenced, and kept up "with some energy at the rate of about one "revolution in five seconds, equal to that "given by a candle eight inches off. There "was some little hesitation as the white side "came up to the spiral, but this was scarcely "noticed when the speed had become steady."

7240 The particular object of the investigations for which this apparatus was constructed was to test a theory which Mr. Crookes had been led to form, as to a certain difference in action on the instrument between light rays, or luminous radiation, and dark heat rays, or non-luminous radiation. He had the idea that these acted in different manner upon the vanes of the radio-meter, and it was while working in this line that he employed currents sufficient to bring the platinum spiral to incandescence.

I find similar apparatus described in another paper read by Mr. Crookes before the Royal Society on January 17, 1878, and published in the Philosophical Transactions for 1878, Part I of the Proceedings for 1878. One form of the apparatus in question is shown in figure 30, page 303, and another in figure 31, page 306. I produce sketches of this apparatus, being reproductions from the original Transactions, on a scale of two to one. 7241

Fig. 30 *Fig. 31* 7242





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The last of these two forms is shown on page 536 of *Nature*, published under date of April 10, 1879.

The description which Mr. Crookes gives of the first form of this apparatus is found on page 303 of the Philosophical Transactions, and is as follows:—

> "This apparatus consists of a wide glass
> "tube, *a*, *a*, *b*, *b*, drawn off narrow at the end
> "*b*, *b*, and a stem *c*, sealed in to hold a needle
> "point; to the narrow end a fine tube, *d*, is
> 7246 "attached, to connect the apparatus to the
> "mercury pump. Round the needle is placed
> "a ring of fine platinum wire, *e*, *e*, the ends of
> "which are joined to thicker platinum wires
> "passing through the glass at *f*, *f*. A cur-
> "rent of electricity from two Grove's cells
> "turned on or off by a contact key, gives the
> "power of making the wire ring, *e*, *e*, red-hot,
> "when desired. The top of the wide tube is
> "ground and polished quite flat, and is cov-
> 7247 "ered by a piece of glass, *g*, which can be
> "cemented on so as to form a perfectly tight
> "joint, and may be removed by warming so
> "as to admit of any experimental fly being
> "supported on the needle point."

This experiment, like the others, was intended to show the differences which were produced by the action of *light* rays and *non-luminous* rays, the section devoted to it bearing the title "Experiments with dark and luminous heat applied internally."

7248 Figure 31 represents the same general apparatus with some slight modification of the internal details, but with the enclosing vessel sealed up by fusion so as to preserve a higher vacuum than would be possible in the apparatus of figure 30, where the vessel is closed by the use of cement.

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I find a description of another similar device, in a paper read by Mr. Crookes before the Royal Society December 5, 1878, and published in the Philosophical Transactions, Part I, of 1879, page 137. The apparatus is shown in Figure 9.

Mr. Crookes says, regarding this apparatus:—

> "492. A tube was made as shown in Fig.
> "9; *a*, *b*, are the two ends of a long platinum
> "coiled into a close spiral and sealed in the 7250
> "bulb. The coils of the wire are not in con-
> "tact, and the ends are sealed in separately
> "so that the spiral can be made red hot by
> "connecting the wires *a* and *b* with the bat-
> "tery."

And a little further on he says, describing the use of the apparatus:

> "The wires *a*, *b*, were now connected with 7251
> "three Grove's cells through a contact key,
> "the induction spark passing at the same
> "time. On pressing the key, the spiral *a b*
> "became ignited to bright redness, and the
> "dark space immediately expanded from 1.75
> "to 2.5 millims. in thickness."

And he then proceeds to describe phenomena observed when this spiral was heated to different degrees of incandescence. 7252

The following is a sketch of this apparatus, being enlarged on a scale of two to one.

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Fig. 9

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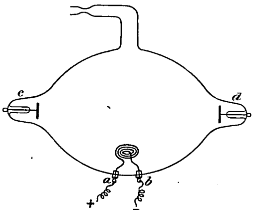

7255 In all of these pieces of apparatus, a high vacuum was obtained by the use of a Sprengel or other mercury pump. The leading-in wires were of platinum, and were sealed into the walls of the enclosing vessel by fusion.

It appears from the statements of Mr. Crookes that in these various pieces of apparatus he desired in many of his experiments to illuminate the vanes of his radiometer by light coming from the platinum spiral or loop. In my opinion, the apparatus when thus
7256 used constituted an incandescent lamp, and might of course have been used within the range of its luminosity for purposes of illumination of external objects, if one so desired. An incandescent lamp is evidently none the less such if it is intended for special rather than for general uses—that is, for illuminating particular objects, which is the case with the surgical or microscopic lamps; neither does it seem to me that the

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organism becomes any less an incandescent lamp, because for a particular purpose it is caused to illuminate an object placed within the vacuous chamber, instead of without it.

It seems to me, therefore, that the apparatus of Mr. Crookes as described contained all of those elements which characterize an incandescent lamp.

58 Q. Have you in your possession any of these Crookes' lamps such as you have described in your answer?
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A. I have one of these of one form, that with the platinum loop, which I have had for a good many years. I have been in the habit frequently of using it, and of showing it to my classes in operation; under those circumstances heating the platinum wire to a bright red by a current from a battery. This was purchased in the open market with a number of other pieces of similar apparatus of Mr. Crookes, which, as I understand, have been kept in stock by the manufacturers. 7259

59 Q. Professor Barker in his answer to cross-question 22, makes a quotation from Schwendler, which, as given by him, is in the following words:

> "If more than one light is produced in the
> " same circuit by the same current, the external
> " or available light becomes rapidly dearer
> " with the increase of the number of lights pro-
> " duced. For this reason already, if not for 7260
> " many others, the division of light must re-
> " sult in an engineering failure."

Please state whether you are familiar with the article from which this quotation is made, and whether the statement quoted has any relation to incandescent lighting?

A. I have been familiar with the article referred to

7261 for a very long time. It was originally printed in the *Journal of the Asiatic Society of Bengal* for March, 1879, and is a statement of the results obtained by Mr. Schwendler in some experiments carried on by him with the electric arc light, with a view to its use by the East Indian Railway Company.

The statements quoted by Professer Barker are found in an appendix to the paper, which appendix contains the experimental results reached by the author. Those results relate solely to the arc light, the only form of
7262 electric light upon which he experimented; and the remark quoted by Prosessor Barker in his answer relates to the arc light alone, and has absolutely nothing whatever to do with any form of incandescent light.

That this is the fact, is particularly clear from the context, as will be seen by a consideration of the sentences immediately preceding those which Prof. Barker quoted, and which I will prefix thereto in their
7263 regular order. The fuller quotation would then read as follows:

"Hence it may be safely asserted, that the "electric light produced by dynamo-electric "machines is on an average 50 times cheaper "than light by combustion. This is, how- "ever, true only as long as the light is pro- "duced in *one* arc.

"If more than one light is produced in the "same circuit by the same current, the ex-
7264 "ternal or available light becomes rapidly "dearer with the increase of the number of "lights produced.

"For this reason already, if not for many "others, the *division of light* must result in "an engineering failure.

"It is in the nature of the electric light that "it should be used in *great intensity* in *one*

"*point*, instead of small intensities in many "points." 7265

It may be well to remark that the expression "the electric light," where used without words of limitation at the date of Mr. Schwendler's paper, was universally understood to mean the light of the electric *arc*. It is also a well-known fact that the electric-arc light is produced in a manner totally dissimilar to the incandescent light; that very different electrical actions come into play in the two cases, and that va- 7266
rious rules and principles which apply to the one are entirely devoid of application to the other.

60 Q. Please state whether you find in the paper of Mr. Schwendler—the authority upon which Professor Barker seems to rely—any recognition of the principle that high resistance of the lamp is necessary in order to secure the distribution of electric light in multiple-arc?

A. I do in the following paragraphs. After a dis- 7267
cussion of various problems with regard to arc lighting, in which there is no reference to incandescent lighting, Mr. Schwendler, in two paragraphs which I will quote, makes a brief statement which applies to incandescent lighting as well as to arc lighting.

"Before I conclude, I must advert to a "paper on the electric light by Mr. W. H. "Preece, published in the *Philosophical Magazine* for January, 1879, in which the "author believes that he has demonstrated 7268
"that the division of the electric light is "impossible. This it certainly is, under the "conditions introduced by Mr. Preece, *namely*, "that the resistance of each voltaic arc or "each incandescent wire is maintained *constant*; but it is not fair to introduce this "condition, especially as it does not at all "represent the question at issue.

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"When a number of lights are connected "in series, the resistance of each must be di- "minished, and when a number of lights "are joined in parallel, the resistance of each "must be increased in proportion to their "number, so as to maintain the total external "resistance constant. If Mr. Preece will in- "troduce this condition into his equations, he "will find that theoretically the division of "the electric light is quite possible; *i. e.*, that
7270 "theoretically, however the lights be arranged, "the unit of light will always be produced by "the same expenditure of energy. Inventors "should not therefore be downhearted. On "the other hand investors in gas need not "hasten to get rid of their shares, for there "are many questions involving practical dif- "ficulties which still remain to be solved; but "at the same time gas companies should be- "ware that they have a formidable rival in the
7271 "field, and bestir themselves to maintain the "lead they hold, by improving their own "means of illuminating and extending its ap- "plication."

The reference of the diminished resistance of lamps when in series and the increased resistance when in parallel, relates principally to important qualifying circumstances which Mr. Preece apparently overlooked in his paper, which Mr. Schwendler in common with many
7272 others criticised so unfavorably; but while referring, even in this merely incidental manner, to the manifest variations in resistance involved in proportioning either an arc or an incandescent lamp for use in series or in parallel circuit, Mr. Schwendler very clearly recognizes that if the light, either the arc light or the incandescent, is to be "subdivided" by placing a number of lamps in

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parallel, those lamps should be given a relatively high resistance; while if they are to be in series they may have a relatively low resistance.

61 Q. Please state whether the article of Mr. Preece, referred to by Mr. Schwendler in the quotation which you have made in your last answer, is the same article from which Professor Barker quoted in answer to cross-question 42?

A. It is the same article. 7274

62 Q. The concluding paragraph of Mr. Preece's article, as quoted by Professor Barker, is in these words:

"It is this partial success in multiplying "the light, that has led so many sanguine ex- "perimenters to anticipate the ultimate suc- "cess of its extensive subdivision, a possibility "which this demonstration shows to be hope- "less, and which experiment has proved to be 7275 "fallacious."

He has quoted this apparently under the assumption that it has to do with the problem of lighting by *incandescence*. Please state whether this assumption is correct?

A. I do not understand that Mr. Preece, in the words quoted, refers in any way to incandescent lighting. That he had in mind only arc lighting, appears from the passage immediately preceding the one quo- 7276 ted, which passage is as follows:

"With the Wallace-Farmer machine the "limit appears to be reached when six lamps "are connected up in series. With the "Gramme alternating machine and Jablochkoff "candles the limit appears to be five lamps. "Beyond these limits the above laws will be "true."

7277 The Wallace-Farmer machine referred to and the Gramme alternating machines were well known arc-lighting dynamos of that date, and the Jablochkoff candle was a well known arc light of the time. The "partial success" which Mr. Preece refers to, was, therefore, the use of six arc lamps in series with the Wallace-Farmer machine, and five arc lamps with the Gramme alternating machine.

Mr. Preece, however, was somewhat behind the
7278 times, at least in his knowledge of the experimental side of this subject. In September, 1878, a number of months prior to the date of the paper under consideration, the Wallace-Farmer machine was exhibited in Boston, running sixteen powerful arc lights in series.

63 Q. What do you understand to have been the problem in relation to the distribution of electric light that was under discussion by Preece and by Schwendler in their respective papers from which
7279 Prof. Barker has quoted?

A. They were considering what was at the time called "the subdivision of the electric light." When attention was first called to the production of the arc light by the use of electricity furnished by a dynamo, nothing in the result was more striking than the amazing cheapness of the light, when, as was the case with all the early machines, a single lamp only was used with the machine. Under these circumstances the cost of the electric light was found to be only a small fraction, perhaps 1 per cent or 2 per cent. of the cost
7280 of gas, or in certain cases even less. But of course the illuminating power of such light was vastly in excess of what was needed at any one point for illumination, except in a few special cases, as for example in lighthouses. It was immediately seen by scientific men and others that if the great amount of light produced at one such focus, could instead be simulta-

7281 taneously produced at a number of different foci, by the expenditure of the same, or substantially the same amount of energy, a form of illuminant would be at hand that would be of the greatest value, and which, provided it could be put in practical shape would supersede ordinary illuminants, such as gas. From this fact that it was desired to distribute, as it were, a given amount of light-giving energy to a great many different points, instead of concentrating it at one point, that is, dividing up the light among many 7282
arcs, instead of utilizing it at one, the term "subdivision of the electric light" arose.

It was to the consideration of this problem that Preece and Schwendler devoted their thoughts, and the assumptions which they make, show such to have been the case. I think this will be clear from even a cursory examination of their papers.

Referring to the result of experiments in which, with a definite current and a definite electro-motive force and the same total resistance in the circuit—that is, 7283
for a definite amount of energy consumed in the circuit, when in one case a single light, and in a second case a number of lights, are used—Mr. Schwendler says:

> "Experiments, however, show that this is "not the case, *i. e.*, the sum of the measured "intensities of *two* smaller lights is perceptibly smaller than the measured intensity "of *one* large light, and that this difference "becomes larger and larger as we increase 7284
> "the number of lights produced by the same "current, *i. e.*, by the same E. M. F. with the "same total resistance in circuit."

And again:

> "That the *measured intensity* of *one* light is "invariably greater than the sum of the

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"measured intensities of *n* lights, is an undoubted fact, proved by many experiments very conclusively."

Again:

"If we produce *two* arcs it will be seen *at once* that the sum of the losses must be greater than the losses in *one* arc."

7286 Immediately afterwards Schwendler says:

"This constitutes one of the reasons why the division of the electric light becomes less and less economical with the increase in the number of lights, and that soon a practical limit shall be reached for the division."

And again:

7287 "The consumption of power per unit of *measured* or *external* light is an increasing function with a number of lights produced by a given current in a single circuit. Supposing, of course, always that the sum of the resistance of the *n* arcs is equal to the resistance of *one* arc, and that the other resistance in the circuit in which no light is produced has remained constant throughout."

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The same thing clearly appears as to the assumptions in Mr. Preece's paper. This is shown by an inspection of his whole process of reasoning.

He assumes in his reasoning either that the electromotive force is constant, in deducing certain of his conclusions, or that the rate of work done by the steam engine, or the rate at which energy is consumed by the

dynamo machine, is constant, assuming the number of light-emitting foci to be varied. 7289

This problem was quite a different one from that which modern electric lighting, either by arc or incandescence, set itself to solve.

The phrase "subdivision of the electric light," thus applied by Preece and Schwendler to the problem of producing several lights, with the same expenditure of energy that would be required to develop an equal volume of light at a single focus, became extended by 7290
popular acceptation so as to cover the different problem of multiplying lights supplied from a single source without attempting thereby to secure the same amount of illumination with the same expenditure of energy; and, as I understand it, it was in this general and popular sense that the phrase was used in Mr. Edison's earlier patents and in publications relating thereto.

64 Q. Then, as I understand you, the real problem which Preece and Schwendler were discussing theoret- 7291
ically, was, whether it was possible to distribute a given amount of electrical energy to several points, and by the conversion of such energy into light at those several points, produce lights whose aggregate volume should be equal to that of one light produced by the concentration of this same amount of energy at a single point, and that it was in this sense that they speak of the "subdivision of the electric light."

Please state whether the experience of the world down to the present time justifies the conclusions which they 7292
reached on this particular question?

A. The uniform experience of the world justifies the conclusion which these writers reached with regard to the particular problem discussed by them. There is no question, and never has been any serious question, that, if a number of lights, either arc or incandescent, are produced at various points by the consumption of a definite amount of energy in them, this procedure is

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very uneconomical as compared with the luminous effect resulting when an equal amount of energy, instead of being divided among a number of lights at different points, is expended in the production of a single light at one point.

65 Q. In his answer to cross-question 41, Prof. Barker again quotes the statement of Mr. Schwendler, to the effect that "the division of light must result in an engineering failure;" as if these words related to
7294 *incandescent* lighting. What is the fact in regard to the use of these words by Schwendler?

A. The statement in the quotation is made entirely with reference to *arc* lighting, as is shown by the context. I have explained this more fully in my answer to interrogatory 59. The words to which my attention is now called, constitute a part of the quotation made by Professor Barker in his answer to question 22, which I fully considered in my said answer 59.

7295 66 Q. In his answer to cross-question 41, Prof. Barker cites a further alleged opinion of Schwendler, which he credits to the *Telegraphic Journal* for 1879, the citation beginning with the words, "unless we 'should be fortunate enough to discover a conductor "of electricity with a much higher melting point than "platinum," etc., and apparently he relies upon this alleged statement of Schwendler to support his own view that in 1876 the principle of high resistance as a condition of the extended subdivision of the incandes-
7296 cent light, was not recognized by persons skilled in the art.

What have you to say in regard to this alleged opinion of Schwendler?

A. I have examined the *Telegraphic Journal* from which Professor Barker has assumed to quote. The reference to Schwendler as contained in said *Journal* is

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very brief, being found on page 395 in the number for December 1st, and professes to be an extract from another publication, the journal of the Asiatic Society of Bengal. The entire paragraph is as follows:

> "Mr. L. Schwendler, in a paper pub-
> "lished in the *Journal* of the Asiatic Society
> "of Bengal, says: 'It appears that light by
> "'*incandescence* is scarcely any cheaper than
> "'light by *combustion*. The reason for this is
> "'that the temperature of an incandescent 7298
> "'platinum wire is not very much higher than
> "'the temperature of a flame, and that for
> "'unit volume the mass which has to be kept
> "'heated in a piece of platinum is much
> "'larger than the mass in a flame.
> "'Unless we should be fortunate enough
> "'to discover a conductor of electricity with
> "'a much higher melting-point than platinum,
> "'and the specific weight and specific heat of
> "'which conductor is also much lower than 7299
> "'for platinum, and which, at the same time,
> "'does not combine at high temperatures
> "'with oxygen, we can scarcely expect that
> "'the principle of incandescence will be
> "'made use of for practical illumination.'"

It will thus be seen that Professor Barker, in making his quotation, omitted what seems to me a very important part of the paragraph, and one which materially modifies the apparent meaning of the part 7300
which he quoted when taken apart from the context.

Taking the whole paragraph into consideration, I do not understand at all that Schwendler was of the opinion that lighting by incandescence had not reached a point where it was as cheap as illumination by gas. Mr. Schwendler thought, as I judge from the statements made in this paragraph, that in order that

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the incandescent light might come into general use, it would be necessary that it should be *very materially* cheaper than the light given by the combustion of ordinary illuminants, such as gas.

In this his opinion coincided with what I understood at the time to be Mr. Edison's opinion. Mr. Schwendler was quite right in the statement with which the quotation opens, for it was true then, and is substantially true to-day, that, broadly speaking, light by incandescence is not cheaper than gas light, and in
7302 most cases it is decidedly dearer.

It ought to be recollected, in order to properly comprehend the aspect of the subject at the date of Mr. Schwendler's paper, that the most exaggerated statements as to what Mr. Edison proposed to do, had been published both in this country and abroad, and that these statements were generally attributed to Mr. Edison himself, and had not been publicly denied either by Mr. Edison or his representatives.

Taking the statement of Mr. Schwendler as con-
7303 tained in the whole paragraph quoted, the meaning which I gather from it is substantially this: Mr. Schwendler had given some attention (how much I have no means of knowing) to the general subject of the relative cost of lighting by incandescence and gas lighting. He had come to the conclusion that lighting by incandescence was not much, if at all, cheaper than lighting by gas, and considered that unless the cost of incandescent lighting could be greatly reduced from its apparent actual cost as deduced by him, it could
7304 scarcely be expected to be made use of in practical competition with gas. Having reached this conclusion in regard to incandescent platinum, the substance which Mr. Edison had tried, and regarding which the various statements purporting to emanate from him had been made, Mr. Schwendler proceeded to state in a general way what should be the properties of

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a substance which might give better success, such as a higher melting-point, lower specific heat, lower specific weight, incombustibility, and so forth.

Mr. Schwendler, I judge, had considered the various substances which would naturally occur to one to make use of in an incandescent lamp, such as platinum, iridium, carbon and the like, and saw that none of these possessed all of the different characteristics which he enumerates as necessary to secure that
markedly high efficiency which he assumed to be nec- 7306
essary, in order that the lamp might successfully compete with gas, and for this reason he concluded that this desirable result could be reached only by the discovery of some new substance possessing the manifold characteristics which he sets forth.

So far was Mr. Schwendler from being in error in regard to the relative economy of gas and incandescent lighting, that even to-day we have not arrived at a point where the incandescent lamp is cheaper than
gas, and certainly not at the point which he considered 7307
it necessary to reach in order to successfully introduce incandescent lighting. The incandescent light has primarily owed its large introduction to other valuable characteristics which it possesses rather than to its cheapness compared with gas.

There certainly is nothing in the alleged quotation in the *Telegraphic Journal*, from the Proceedings of the Asiatic Society, to justify the inference that Schwendler did not fully recognize the value of the
principle of high resistance in the incandescent lamp 7308
as necessary to the wide distribution of the electric light.

67 Q. When approximately were the Geissler and Sprengel pumps brought into practical use?

A. The Geissler pump was brought out about 1868, the Sprengel pump in the year 1865.

7309 Defendant's counsel offers in evidence printed patent office copies of the following United States patents :

No. 213,643, granted to Moses G. Farmer, March 25, 1879, which is marked "Defendants Exhibit Farmer U. S. Patent."

No. 227,229, granted to Thomas A. Edison, May 4, 1880, which is marked "Defendant's Exhibit Edison U. S. Patent No. 227,229."

No. 237,732, granted to Thomas A. Edison February
7310 13, 1881, which is marked "Defendant's Exhibit Edison U. S. Patent No. 237,732."

No. 369,280, granted to Thomas A. Edison February 11, 1887, which is marked "Defendant's Exhibit Edison U. S. Patent No. 369,280."

Also blue-book copies of the following British patents :

No. 10,919, granted to Edward Augustin King, dated November 4, 1845, which is marked "Defendant's Exhibit King British Patent."

7311 No. 14,198, granted to Martyn John Roberts, dated July 6, 1852, which is marked "Defendant's Exhibit Roberts English Patent."

No. 188, granted to Morris, Weare & Monckton, dated January 24, 1862, which is marked "Defendant's Exhibit Morris, Weare & Monckton British Patent No. 188."

No. 1,516, granted to Morris, Weare & Monckton, dated May 19, 1862, which is marked "Defendant's Exhibit Morris, Weare & Monckton British Patent No.
7312 1,516."

No. 1651, granted to Adolphe Mirouде, dated June 20, 1866, which is marked "Defendant's Exhibit Mirouде British Patent."

No. 2,717, granted to George Haseltine, dated August 5, 1874, which is marked "Defendant's Exhibit Haseltine British Patent."

No. 2,194, granted to De Sussex & Brasseur, dated

June 5, 1877, which is marked "Defendant's Exhibit De Sussex & Brasseur British Patent." 7313

No. 861, Provisional Specification filed by Francis Scott March 2, 1878, which is marked "Defendant's Exhibit Scott British Patent."

No. 3,988, granted to St. George Lane-Fox, dated October 9, 1878, which is marked "Defendant's Exhibit Lane-Fox British Patent No. 3,988 of 1878."

No. 4,043, granted to St. George Lane-Fox, dated 7314
October 12, 1878, which is marked "Defendant's Exhibit Lane-Fox British Patent No. 4,043 of 1878."

No. 4,626, granted to St. George Lane-Fox, dated November 13, 1878, which is marked "Defendant's Exhibit Lane-Fox British Patent No. 4,626 of 1878";

No. 4,774, granted to Isaac Louis Pulvermacher, dated November 23, 1878, which is marked "Defendant Exhibit Pulvermacher British Patent";

No. 1,122, Provisional Specification filed by St.
George Lane-Fox, March 20, 1879, which is marked 7315
"Defendant's Exhibit Lane-Fox British Patent No. 1,122 of 1879";

No. 2,402, granted to Thomas A. Edison, dated June 17, 1879, which is marked "Defendant's Exhibit Edison British Patent No. 2,402 of 1879";

No. 578, granted to Thomas A. Edison, dated February 10, 1880, which is marked "Defendant's Exhibit Edison British Patent No. 578 of 1880";

No. 602, granted to Thomas Edison, dated February
11, 1880, which is marked "Defendant's Exhibit Edi- 7316
son British Patent No. 602 of 1880";

No. 3,765, granted to Edward G. Brewer upon communication from Thomas A. Edison, dated September 16, 1880, which is marked "Defendant's Exhibit Edison British Patent No. 3,765 of 1880."

It is stipulated that the ordinary printed Patent Office copies of United States patents, and ordinary blue-book printed copies of British patents, may be

7317 used in evidence by either party with the same force and effect as duly certified copies, and that the dates of filing the applications for United States patents, and of filing Provisional and Complete Specifications, and of sealing British patents, are when stated, correctly stated upon said printed copies, subject to correction in case any mistake is found therein at any time before the hearing.

It is further stipulated that the Blue-book copies of
7318 the Lane-Fox British patents, offered in evidence above, were published and put on sale at the following dates:

No. 3,988 on May 24th, 1879;
No. 4,043 on May 16th, 1879;
No. 4,626 on June 26th, 1879; and
No. 1,122 on October 18th, 1879;

and that the various other Blue-books were published and placed on sale during the years stated in the imprints on the covers of the same, subject to correction
7319 by proof at any time before the hearing.

Defendant's counsel offers in evidence a copy of French Letters Patent No. 130,910, granted to Thomas Alva Edison, dated May 28, 1879, and also a translation of the specification of said patent, which are marked respectively, "Defendant's Exhibit Edison French Patent No. 130,910," and "Defendant's Exhibit Translation of Edison French Patent No. 130,-910."

It is stipulated that the said copy of said French
7320 patent is a correct copy, and also that the paper offered as a translation of the specification of said patent is a correct translation thereof, subject to the correction of any errors which may be found in either the said copy or said translation at any time before the hearing herein; that the said French patent was issued during the month of June, 1879, and that an Italian patent, substantially indentical with said French patent, was granted to Mr. Edison on the 23d day of June, 1879.

7321 Defendant's counsel also offers in evidence a translation of a certificate of addition, dated April 7, 1877, by Octave Gauduin, to the French letters patent granted to said Gauduin July 12, 1876, numbered 113,706 and the same is marked "Defendant's Exhibit Gauduin Certificate of Addition."

It is stipulated that the paper offered in evidence is a correct translation of the said Certificate of Addition, that the said Certificate was filed and granted as stated therein, and Complainant's counsel waives the production and putting in evidence of a copy of the original 7322
patent and of a copy in French of the said Certificate of Addition.

Defendant's counsel also offers in evidence, pages 173 to 177 inclusive, of Vol. 28 of the Proceedings of the American Association for the Advancement of Science, being an article entitled "The Phenomena of Heating Metals in Vacuo by means of Electric Currents," by Thomas A. Edison, Menlo Park, New Jersey, and the same is marked "Defendant's Exhibit American Association Paper." 7323

It is stipulated that a typewriter copy may be used in place of the book; that the meeting before which said paper was read was held in August, 1879, and that the volume of Proceedings containing said article was published in 1880.

Defendant's counsel also offers in evidence an article printed on pages 320 and 321 of the Telegraphic Journal and Electrical Review, published by Naughton & Company in London, October 1, 1879, being the article entitled "Heating Metal in Vacuo by Electric Cur- 7324
rents" and the same is marked "Defendant's Exhibit Telegraphic Journal Article of October 1, 1879."

Defendant's counsel also offers in evidence pages 413, 414 and a part of page 415 of the Telegraphic Journal for October 15, 1878, being two articles entitled respectively, "Gas v. Electric Light" and "Edi-

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son Electric Light," and the same is marked "Defendant's Exhibit Telegraphic Journal Articles of October 15, 1878."

Defendant's counsel also offers in evidence pages 390 to 399, inclusive, of Du Moncels Notice sur l'Appareil d'Induction-Electrique de Ruhmkorff, published at Paris by Gauthier-Villars, in 1867, with a translation of the same, which are marked "Defendant's Exhibit Du Moncels Article on Geissler-tube lamps."

It is stipulated that a copy may be used in place of
7326 the book and that the translation is correct, subject to the correction of any errors that may be found therein prior to the hearing.

Defendant's counsel also offers in evidence an extract from Les Mondes, published at Paris by the Bureaux des Mondes in 1875, Vol. 36, pages 183 to 185, and a translation of the same, which are marked "Defendant's Exhibit Wilde's Report on the Lodyguine lamp."

It is stipulated that the said translation is correct
7327 subject to the correction of any errors which may be found therein at any time before the hearing.

Defendant's counsel also offers in evidence extracts from the printed Bulletins issued by the Edison Electric Light Company as follows: pages 41 to 50 of the 20th Bulletin, dated October 31, 1883; and pages 54 to 62 of the 21st Bulletin, dated December 18, 1883; and the same are marked "Defendant's Exhibit Extracts from Edison Bulletins."

It is admitted by Complainant's counsel that the
7328 said bulletins were issued by the Complainant on or about the dates above stated.

It is stipulated that the article from Nature quoted by Prof. Cross in his answer to Q. 23, the article quoted by Prof. Cross in his answer to Q. 55 from Vol. 10, of the Proceedings of the Royal Society of London, and the extract from Faraday's Chemical Manipulations contained in Prof. Morton's answer to

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Q. 26, are correctly quoted and that the various publications referred to were published as stated in said answers.

Defendant's counsel also offers in evidence a translation of an article by M. Sidot, published in the Comptes Rendus of the Academy of Science at Paris in 1870, and the same is marked "Defendant's Exhibit Sidot Paper."

It is stipulated that the paper offered is a correct translation and that the original article was published 7330
as stated.

Defendant's counsel also offers in evidence the following papers of William Crookes as printed in the Philosophical Transactions of the Royal Society of London, viz.:

"On Attraction and Repulsion resulting from Radiation," read December 11, 1873, and published in 1874, in the Transactions for the year 1873.

"On Repulsion resulting from Radiation," Part II, 7331
read April 22, 1875, and published in the year 1876, in Part II of Vol. 165 of the Transactions for the year 1875; Parts III and IV. read Feb. 10 1876, and published in 1877 in Part II of Vol. 166 of the Transactions for the year 1876; Part V. read before the Royal Society January 17, 1878, and published in Part I, of Vol. 169 of the Transactions for that year.

"On the Illumination of Lines of Molecular Pressure and the Trajectory of Molecules;" read Dec. 5, 1878, and published in the year 1879 in the Transac- 7332
tions for the year 1878.

It is stipulated by Complainant's counsel that the several volumes of the Philosophical Transactions above referred to were published in London by Harrison & Sons in the respective years above stated, and that the several papers of Mr. Crookes now offered in evidence were presented and read before the Royal Society at the several dates named in the printed Transactions.

Adjourned subject to agreement of counsel.

7333

NEW YORK, February 27, 1890.

Met pursuant to adjournment. Present—Counsel as before.

CHARLES R. CROSS, cross-examined by Mr. Dyer:

68 x-Q. Did you testify for the Complainant in the case of the Consolidated Electric Light Company versus the McKeesport Electric Light Company, lately
7334 pending in the Western District of Pennsylvania and decided by Mr. Justice Bradley?

A. I did.

69 x-Q. Is it not a fact that the patent in suit in that case was the Sawyer and Man Patent No. 317,676 granted May 12, 1885?

A. It is.

70 x-Q. Please look at Vol. II of the Complainant's Record in that case and state between what dates your deposition was given?

7335 A. Between April 2d and April 20th, 1889.

71 x-Q. I read from your deposition in that case questions and answers, to wit: 7 to 38; 44 to 61; 68 and 69; 79 to 81; 133 to 135; 197 and 198; 205 to 221; 224 and 225; 233 to 240; 251 to 286; 288 to 290; 298 to 300; 310 and 311; 314 to 325; 332 and 333, as follows:—

"7 Q. Professor Brackett, defendant's ex-
"pert, says is substance, in his answer to
"question 5, 'that in view of the prior pa-
7336 "'tents and publications, put in evidence by
"'the defendant, there is not, in his opinion,
"'any novelty in the use of vegetable fibrous
"'carbon as the incandescent conductor of
"'the lamp of the patent in suit;' and Pro-
"fessor Barker, in his answer to question 9
"agrees with him in the opinion so expressed.
"Do you agree with this opinion of defend-

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"ant's expert? Please read, in addition to
"the questions and answers I have referred
"to, Prof. Brackett's answers to cross-ques-
"tions 41, 42 and 43, and Prof. Barker's an-
"swers to question 47, and cross-questions
"51–55 inclusive, and to cross-question 63,
"and give your reasons for any opinion you
"may express.

"A. I do not agree with the statements of
"defendant's experts referred to in the ques- 7338
"tion. I have considered very carefully the
"various prior patents and publications put in
"evidence by defendant, and neither in these
"nor in any other publication with which I
"am acquainted do I find the use of vegetable
"fibrous carbon as described in the Sawyer
"and Man patent in suit set forth.

"My reasons for holding the views which
"I entertain in opposition to those held by
"defendant's experts can best be made clear 7339
"by a consideration of the various patents
"and publications which the defendant has
"put in evidence. It will simplify matters if
"I group together those patents and publica-
"tions in evidence.

"Defendant's exhibits Nos. 1–14 inclusive,
"comprehending the various papers from the
"Philosophical Transactions, the collected
"papers of Sir Humphrey Davy, the articles
"from the American Journal, *Comptes Ren-* 7340
"*dus*, and Watt's Dictionary of Chemistry,
"are simply descriptions of interesting and
"important scientific investigations and ex-
"periments, but which neither describe elec-
"tric lamps, nor purport to do this. Many
"of them have no relation whatever to incan-
"descent lighting, and some have no relation

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" to any kind of lighting whatever, the object
" of the experiments described therein being
" in some cases of purely theoretical interest
" and in others relating to arts which are
" widely different from electric lighting.

" Several of these papers relate solely to
" processes of carbonization, and merely show
" the state of the art so far as carbonization
" in general is concerned, but without regard
7342 " to the bearing of this subject on electric
" lighting by incandescence.

" A second group of the exhibits relates
" only to arc lighting and to the preparation
" of carbons for this purpose. Such are the
" patents to Slater and Watson (Defendant's
" Exhibit No. 21), an English patent; Bink's
" English patent (Defendant's Exhibit No. 23);
" Harrison's English patent (Defendant's Ex-
7343 " hibit No. 25); Barleigh and Danchell's En-
" glish patent (Defendant's Exhibit No. 26);
" LeMolt's French Patent (Defendant's Ex-
" hibit No. 37); and the Gaudoin French
" patent with certificates of addition (De-
" fendant's exhibit No. 40). These throw
" absolutely no light upon the selection
" or use offibrous carbon for incandescent
" lighting. On the contrary, so far as
" they have any effect whatever, they tend
" to lead one in precisely the wrong di-
7344 " rection. The requisites of carbon suitable
" for arc lighting are quite the reverse of the
" requisite for carbon to be employed in incan-
" descent lighting. The carbon pencils for
" arc lighting should be exceedingly hard and
" very incombustible, so that they may wear
" away but slowly in the air; and they
" should moreover have as slight a resistance

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" as possible, in order that it may not interfere
" with the passage of electricity along their
" length. In arc lighting the work should all be
" done in the arc itself, and whatever resistance
" is offered to the passage of electricity
" through the pencils is a dead loss; and this
" is by no means a matter only of theoretical
" interest. On the contrary, it is practically
" very important, so that the custom is al-
" most universal of electro-plating carbons 7346
" for arc lighting with copper, in order to di-
" minish the resistance which is offered to
" the passage of the current through the
" length of the conductor. Such is evidently
" not the case with the incandescent light,
" since the incandescent strip, filament or
" pencil is to be rendered incandescent
" throughout its whole length, and must there-
" fore offer a high rather than a low resist-
" ance to the passage of the current through- 7347
" out its whole substance.

" A third set of patents and publications
" relate only to arc-incandescent or similar
" lamps. These exhibits are defendant's ex-
" hibit No. 15, Pinkus English patent; No. 6,
" De Moleyn's English patent; No. 18,
" Greener & Staite's English patent; No. 20,
" Shepherd's English patent; No. 24, Way's
" English patent; No. 27, Way's English pat-
" ent; No. 29, Konn's English patent of 1873; 7348
" No. 32, Werdemann's English patent: No.
" 33, Varley's English patent. The necessi-
" ties for an arc-incandescent light, or for
" any of the lamps referred to in these pat-
" ents, are very different from those arising
" in incandescent lighting, and there is noth-
" ing in any of these patents which in any way

7349 "directs the attention of the reader towards "the matters set forth and described in the " Sawyer and Man patent in suit.

"A fourth group of devices comprehends "those described in defendant's exhibit No. "19, Staite's English patent, and No. 34, "Gardiner and Blossom's U. S. patent. These "relate to incandescent lamps, but not to in-
7350 "candescent lamps employing carbon con- "ductors, since both of the patents in ques- "tion set forth the use of conductors of metal "only.

"The only exhibits introduced in evidence "by the defendant which refer to incandes- "cent lamps with a carbon incandescing con- "ductor, are the following: No. 17, King's "English patent; No. 22, Robert's English "patent; No. 28, King's English patent of
7351 "1872; No. 30, Kosloff's English patent; "No. 31, Jensen's English patent; No. 35, "Kosloff's U. S. patent; No. 38, Mechanics "Magazine article, describing the King "lamps; No. 39, Journal of the Society of "Arts article, referring to the Lodyguine "lamp. Among all of these lamps there are "three only which are alleged by defendant's "experts to set forth the use of any particu- "lar kind of carbon, and it is therefore evi-
7352 "dent without further consideration that the "others could in no way direct one wishing "to practice the art of incandescent lighting "towards the use of that particular kind of "carbon referred to in the Sawyer and Man "patent in suit With regard to the three "particular patents to which I have referred, "I find them exceedingly indefinite, ambigu- "ous, and calculated to confuse rather than

"to enlighten the mind of one reading them. 7353
"I think that the justice of my conclusion "will better be made evident by a specific, "though brief consideration of them.

"I will consider first the British patent to "Konn., No. 3,809, of 1872. In this patent, "which is a communication from Lodyguine "of St. Petersburgh, there are described "several forms of incandescent lamp in which "carbon is used as the incandescing conduc- 7354
"tor. The only particular form of carbon "which is referred to in the patent is graphite- "the patentee saying that the incandescing "conductors are to be made 'preferably of "'graphite.' This lamp is referred to by de- "fendant's expert, Prof. Barker, in his an- "swers to question 47, and cross-question 53. "From the fact that Konn states that the in- "candescing conductors for his lamp are to be "made 'preferably of graphite,' it seems to 7355
"me unquestionable that his intention was, "and that the effect of his patent necessarily "would be, to guide one reading it and desir- "ing to put into practice the intention there- "in set forth to the use of such graphite or "gas carbon as was well known in the arts in "connection with electric lighting. It is prac- "tically a statement that to get the full bene- "fit of his invention one must employ that "kind of carbon which possesses those pecu- 7356
"liarities which were known to be possessed "by graphite, especially among different kinds "of carbon. There is not in the patent the "remotest intimation that anything but dis- "advantage could result from using carbon "other than graphite carbon; and an elec- "trician wishing to construct an incandescent

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"lamp of the character subsequently invented
"by Messrs. Sawyer and Man, and set forth
"in the patent in suit, would have to turn
"his back upon the patent to Konn and walk
"directly away from it and from everything
"which it contains in order to reach his
"goal.

"I observe that Prof. Barker draws a dif
"ferent inference from my own in regard to
7358 "the statement of Konn's that his incandes-
"cing conductors were to be made 'prefer-
"ably of graphite.' Prof. Barker states that
"to him this 'clearly indicates' that Konn
"was fully aware that carbon in other forms
"was suitable for the purpose, and that these
"other forms had already been known and
"used as incandescing conductors for electric
"lamps. It does not seem to me that Konn's
"statement justifies the conclusion which
7359 "Prof. Barker draws from it. On the contrary
"it appears to me that whatever Konn may or
"may not have been aware of, he intended to
"state, and does distinctly state, that for an
"incandescent lamp, such as he describes,
"graphite is pre-eminently the thing to be
"used, and that other kinds of carbon are dis-
"tinctly not the things to be chosen by one
"wishing to practice his invention.

"Adjourned till 2.10, P. M.

7360 2.30 P. M.

"The 'Golos article' referred to in an
"article in the Journal of the Society of Arts,
"for August 22, 1873, Defendant's Exhibit
"No. 39, relates to certain experiments with a
"lamp of Lodyguine. There is no scientific
"description of the lamp, but only a brief,
"popular statement which shows that it was

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"an incandescent lamp having a carbon con-
"ductor. Referring to this lamp, the article
"says 'only one piece of charcoal or other
"bad conductor is required;' and the same
"term 'charcoal' is applied to the conductor
"in the latter portion of the same sentence,
"and once again in a subsequent sentence in
"which it is stated that 'the charcoal becomes
"gradually and equally heated.' The word
"'charcoal,' as used in this publication, how-
"ever, does not denote any kind of *fibrous* 7262
"carbon, as will immediately appear from the
"consideration of the manner in which the
"same word is used somewhat earlier in the
"same article. Referring to the electric arc,
"it is spoken of as being formed 'between
"two points of charcoal,' and it is further
"said that difficulties arose from 'the rapid
"consumption of the charcoal points.' There
"can be no question, therefore, that the word
"charcoal,' as used in this publication, in no 7263
"way refers to fibrous carbon, but rather to
"the hard gas-retort carbon which, at the
"date of publication of that article, had for
"many years in Russia as elsewhere been em-
"ployed in arc lighting.

"That I am correct in my view, that the
"term 'charcoal,' is employed in this article
"with reference to gas carbon, will further ap-
"pear from a consideration of certain English
"patents relating to the same or similar forms 7264
"of lamp, and originating with the same per-
"son or his colleagues.

"The Golos article refers to Messrs. Kos-
"loff & Co. of St. Petersburgh, as the proprie-
"tors of Mr. Lodyguine's patent for this in-
"vention, and Lodyguine was apparently
"connected in some way with this firm.

7365
" British patent to Konn, of the firm of S.
" A. Kosloff & Co., No. 3,809, of 1872, Defen-
" ant's Exhibit No. 28, which is a communica-
" tion by A. N. Lodyguine, of St. Petersburgh,
" describes a new form of incandescent lamp,
" devised by the latter. Throughout this
" patent, wherever the material employed by
" it is specifically mentioned, it is stated to be
" graphite, which I understand to mean the
" material which had ordinarily been used for
7366 " arc-light pencils. There are several other
" patents for incandescent lamps coming from
" the same firm. Konn's English Patent, No.
" 91 of 1873, describes an incandescent lamp
" employing 'solid stems of carbon,' and the
" behavior of the 'carbon stems' in this lamp
" is contrasted with the behavior of the 'car-
" bon stems' as used in the arc light;
" from which I should infer without question
7367 " that the same kind of carbon, that is, hard
" carbon, was referred to in each case. Also,
" British Patent to Kosloff, No. 441 of 1875,
" describes another form of incandescent lamp
" in which 'sticks of carbon' are made in-
" candescent by the passage of a current
" through them. The specific form of carbon
" to be employed is not stated in terms in
" this patent, but I think that there can be
" no question that the patentee referred to
7368 " such carbons as were used in electric arc-
" lighting, and that this is the sense in which
" the patent would be understood. The pat-
" entee speaks of 'the carbons' of the lamps
" in precisely the same way in which it was
" customary to speak of the pencils used in
" arc-lighting as 'the carbons,' which he
" would have been very likely to do if they

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" had not been of the same character. Also,
" British Patent, No. 976 of 1875, to Jensen,
" is a communication from Konn of St.
" Petersburgh. It describes further improve-
" ments in the incandescent lamp. In this
" patent the rods are also spoken of as made
" of carbon.
" In none of these English patents is there
" any reference to any kind of carbon other
" than graphite, and in the Golos article it is 7370
" clear, as I have shown, that the word char-
" coal is used as meaning hard carbon.
" The statement in the Golos article reads
" very much as if translated or paraphrased
" from the French, and I have an impression
" that the periodical referred to employs that
" language; but whether this is, or is not the
" case, it is clear that there is not the slight-
" est reference in the Golos article to the use
" of fibrous carbon in an incandescent lamp. 7371
" British Patent to Roberts, No. 14,198 of
" 1852, contains a description of an incandes-
" cent lamp employing a conductor of carbon.
" He generally refers to this conductor as made
" of graphite. In stating his invention, how-
" ever, he says, that it 'consists of a mode of
" 'obtaining electric light by passing a current
" 'of electricity through a thin piece of gra-
" 'phite, coke, charcoal or other infusible body
" 'being a conductor of electricity.' This state- 7372
" ment seems to be a very general one, and in-
" tended to indicate only that some form of
" conducting carbon should be employed. It
" certainly does not at all intimate the em-
" ployment of vegetable fibrous carbon as in
" the patent in suit.
" For the reasons stated I find myself quite

7373 "unable to agree with the views regarding
"this matter expressed by Professors Brac-
"kett and Barker in their answers referred to
"in question.

"8 Q. In what sense do you understand
"the word 'charcoal' to be used in the Rob-
"erts patent to which you have just referred?
"A. It seems to me that Roberts merely
7374 "intended to indicate by his reference the
"general use of carbon rather than the spe-
"cific use of any particular kind, and he
"apparently uses language to indicate sever-
"al forms of conducting carbon. It seems to
"me from the particular forms that he men-
"tions, that he perhaps had in mind natural
"graphite or plumbago, indicated by the word
"graphite; artificial carbons made from pul-
7375 "verized coke, and indicated by the word coke:
"and gas-carbon as indicated by the word
"charcoal. Such a use of terms would be
"quite in the line of that usage which I have
"already pointed out in my answer to ques-
"tion 3.

"9 Q. Assuming that the word charcoal in
"the Roberts' patent is to be taken in its pop-
"ular sense of wood charcoal, does the Roberts'
"patent indicate any preference for such
7376 "charcoal, or contain any statements which
"would lead a person skilled in the art to se-
"lect such charcoal as specially suitable for
"use as the incandescent conductor of an elec-
"tric lamp?
"A. It does not in any way. Charcoal is
"merely mentioned, and that but once only,
"in the general statement of invention, as an
"infusible body which is a conductor of
"electricity, and the patentee suggests the

"use of any body whatever of this kind as 7377
"suitable for his purpose. There is abso-
"lutely nothing in the patent to indicate the
"necessity of the conductor possessing any
"property except that of being infusible; and
"the patentee does not indicate any advan-
"tage in one of these forms over another, ex-
"cept in so far as his constant reference to
"graphite would indicate his preference for
"this; so that, if one reading the patent in- 7378
"ferred that the word charcoal referred to
"the article of commerce popularly known as
"charcoal, he would in no way be led from
"anything in the Roberts patent to employ
"such charcoal in preference to any other
"form of carbon, as, for example, graphite or
"coke. I should say that, even if he under-
"stood the word charcoal to be used in its
"popular sense, as indicated in the question,
"the statements of the patent would lead him 7379
"to employ the more infusible and less de-
"structible forms of carbon mentioned therein,
"and especially graphite, which is the partic-
"ular form most frequently referred to.

"10 Q. Assuming that the term charcoal,
"as used in the Roberts English patent, and
"in the description of the Lodyguine lamp
"published in the *London Journal* of the So-
"ciety of Arts, is to be taken as meaning the 7380
"article of commerce popularly known as
"charcoal, would either of these, in your
"opinion, constitute a description of the use,
"in an electric lamp, of the incandescing con-
"ductor of carbonized fibrous material of com-
"plainant's patent in suit?
"A. It would not. What is popularly

7381 "known as charcoal is a material not fitted "for use as the incandescing conductor of an "incandescent lamp. It is imperfectly car-"bonized, uneven in its structure, and its elec-"trical resistance would be irregular. All of "these qualities tend to render it ill-fitted for "use in an incandescent lamp; moreover, in "shaping the conductor it would be necessary "to cut across the fibres, which would be very
7382 "undesirable, and would seriously interfere "with its utility. It might be possible to "produce an incandescing conductor made "from the charcoal of commerce, which "could be used for a short time in an incan-"descent lamp, but, if possible, this could "only be done as a sort of 'tour de force' of "the skilled workman undertaking it, and it "could not be made commercially useful.
7383 "What is popularly understood as charcoal "is a very different thing from such carbon-"ized fibrous material as is set forth in com-"plainant's patent in suit, which implies a "perfectness of carbonization and a choice of "material not found in the charcoal of com-"merce, and not suggested by the use of that "term.

"11 Q. Do you agree with the opinion ex-"pressed by defendant's expert, Prof. Brack-
7384 "ett, in his answer to question 5, that the ad-"vantages of the arch or horseshoe form of an "incandescent conductor for an electric lamp "are present, whatever may be the material, "whether it is metal or carbon?

"A. I do not agree with Prof. Brackett in this "opinion. A very important advantage of "the horseshoe form with carbon consists in "the fact that it permits the material to

7385
"readily alter its shape with change of tem-"perature. With platinum, or any other "metal which is not brittle, this is an unim-"portant matter, since the metal readily "bends, more or less, as is necessary to adapt "itself to the conditions of stress which arise "within it when its temperature changes. "Hence, with metal as an incandescing con-"ductor, so far as this particular point is con-"cerned, it makes no difference whether the 7385
"conductor is straight or arch-shaped; but "with carbon as an incandescing conductor, "the reverse is the case. This material is "brittle, and cannot adapt itself to any ma-"terial extent to such stresses as are produced "by its change in temperature. It is there-"fore exceedingly liable to breakage from ex-"pansion or contraction if it is used in the "form of a straight strip. Liability to rup-"ture from this cause was well known in the 7387
"arts at the date of the Sawyer and Man pat-"ent in suit, and is frequently referred to in "various patents and publications. It is, "moreover, referred to at length in the Saw-"yer and Man patent in suit.

"It seems to me, therefore, that there is "clearly a great value in the arch-formed in-"candescing conductor, as contrasted with "all other forms of conductor in incandescent "lamps when *carbon* is used for that conductor, 7388
"which does not exist in incandescent lamps "employing *metal* as the incandescing con-"ductor.

"12 Q. Do you agree with the opinion ex-"pressed by Prof. Brackett in his answer to "question 33, and by Prof. Barker in his an-"swer to question 43, that the advantage to

7389 "which you have just referred is not present "in the lamp described in the patent in suit, "but that the conductor there shown and de- "scribed is as liable to fracture in the arch "form shown as it would be in the form of a "straight rod ?

"A. I do not agree with Profs. Brackett and "Barker in this opinion. On the contrary, "it seems to me evident that the arch-shaped
7390 "form is one which produce, much less tend- "ency to rupture when the carbon is heated "or cooled, than if it were straight. I do not "see that the mere fact, suggested by Prof. "Brackett, that the conductor is a somewhat "thick one, deprives the arch-shaped con- "ductor of its confessed value. A thick fil- "ament would very likely be more brittle, "other things remaining the same, but such "brittleness would be more harmful in a
7391 "straight conductor than in an arch-shaped "conductor. Moreover, my understanding "has been that it was a matter of confessed "experimental knowledge that the arch- "shaped carbon possessed this advantage "over the straight carbon.

"13 Q. Do you agree with the opinion ex- "pressed by Prof. Barker in his answer to "cross-question 53, that the advantages set
7392 "forth in the patent in suit as belonging to "the arch form of incandescent conductor, "are secured to the same extent by the form "of the said conductor shown in the Roberts "English patent ?

"A. I do not. The Roberts patent de- "scribes a lamp containing an incandescent "conductor of carbon, in which a straight con- "ductor is employed, as I have already ex-

"plained in my answer to question 7. This 7293
"straight carbon possesses none of the ability "of free expansion or contraction, with "change of temperature, which is a special "advantage of the arch-shaped form as set "forth in the Sawyer and Man patent in suit.

"Adjourned till 8 P. M.

"Resumed at 8 P. M. 7294

"14 Q. Do you agree with Prof. Brackett "in the opinion he expressed in answer to "question 35, that in the modern incandes- "cent lamp the advantages arising from the "capacity of the conductor to contract and "expand without breaking or disturbing the "position of the fixed terminals, would be "present, whatever the form of the conduct-
"or, whether that of a loop or of a straight 7295
"piece ?

"A. I do not agree with Prof. Brackett in "the opinion referred to. It seems to me "that with a straight carbon fixed at the ex- "tremities, there would necessarily and evi- "dently be much greater likelihood of rup- "ture than with the horseshoe form ; the "rigid extremities would not allow the car- "bon to accommodate itself to changes in
"temperature, and the stress produced in it 7296
"by such change could hardly fail to exert a "deleterious influence. I am confirmed in "this opinion from the fact that in certain "forms of incandescent lamp that I have "seen, in which a straight carbon was em- "ployed, delicate and complex mechanical

7397 "arrangements were necessary to suitably
"support the carbon in order to prevent its
"breaking. Still further, a straight carbon
"would be liable to injury in transportation,
"on account of its greater rigidity, to which
"the horseshoe filament would be much less
"subject.

"15 Q. Was the liability of the carbon
7398 "conductor to fracture from the effects of ex-
"pansion and contraction, recognized in the
"art as a defect of the incandescent lamps
"having straight carbon conductors which
"were known prior to 1880?
"A. It was fully recognized and stated in
"printed publications, as will be seen, for
"example, by reference to the description of
"the electric lamp described by Kosloff in
"British patent No. 441 of 1875. In this
7399 "patent the defect in question is described,
"and a particular device for avoiding the dif-
"ficulty is also explained. A similar device
"is also found described in Jensen's British
"patent No. 970 of 1875. The difficulty un-
"der consideration is also alluded to in U. S.
"patent to Sawyer and Man, No. 210,809,
"and a device for remedying it is described
"in that patent.

"16 Q. As a matter of fact, what is the form
7400 "of the incandescent conductor used in in-
"candescent lamps which have gone into
"commercial use since 1880?
"A. In all cases which I recall of lamps
"commercially used, the arch-shaped form
"has been employed. Sometimes a simple
"arch, as figured in the Sawyer and Man

"patent, or as used, for instance, in the 7401
"Edison lamp, sometimes an M-shaped car-
"bon with rounded angles, as in the Maxim
"lamp, sometimes a sinuous carbon, as in one
"of the Weston lamps, and sometimes a hel-
"ical carbon, as in the Swan lamp, have been
"employed.

"17 Q. Do you agree with the opinion ex-
"pressed by Prof. Brackett in his answer to
"question 5, that a V-shaped burner and 7402
"burners with rectangular bends, instead of
"curvilinear ones, are described in the patent
"in suit as equivalent in shape for the
"arch or horseshoe form?
"I do not. Messrs. Sawyer and Man state
"that they have used V-shaped conductors
"and conductors with rectangular bends, but
"they distinctly state that they prefer the
"arch-shape, from which I understood that
"they regard this last as having a distinct 7403
"advantage over the others, so that these
"are not equivalents for it.

"18 Q. Do you agree with Prof. Brackett in
"the opinion he expresses in answer to ques
"tion 6, that the arch or horseshoe shape
"described and claimed in the patent in suit,
"was old in carbons? Please consider in
"this connection Prof. Brackett's answer
"to questions 5 and 9, and Prof. Barker's 7404
"answers to question 14 and to cross-ques-
"tions 64 and 65.
"A. I do not agree with Prof. Brackett in
"his opinion as referred to. In none of the
"patents and publications which have been
"put in evidence, nor in any others of
"whose existence I am aware, is there any

7405 "reference to the use of an arch-shape or "horseshoe conductor formed of carbon. The "only carbon conductor other than a straight "strip which is shown in any of the publi- "cations put in evidence is the V-shaped "carbon shown in the British patent to Konn, "No. 3,809, of 1872.

"In my opinion, a V-shaped carbon is not "an equivalent of the horseshoe conductor
7406 "of carbon, for there is not the same liberty "of free expansion or contraction with the "former which exists with the latter, as the "two arms of the V would be thrust the one "into the other, inducing liability to frac- "ture; also in such a conductor the lines of "flow of the current through the apex of the "V would not be uniform, so that it would "become unequally heated at different points, "and thus give less satisfactory results than
7407 "if the form were that of an arch.

"But still more than this, in the Konn lamp "under consideration, the incandescing con- "ductor is not the V-shaped carbon as a "whole, but simply the apex of the V. The "patentee describes the carbons for his lamp "as made thinner in the middle, and with "reference to the lamp having the V-shaped "conductor, says that the current passed "down one side of the V and up the other
7408 "side, 'the light being formed at the angle "'at the bottom.' I therefore quite fail to "see that the use of the V-shape in this lamp "is at all material, so far as concerns any of "the advantages of the arch form that I have "pointed out. It simply allows of a rather "more convenient mounting, and avoids "shadows. In fact, the two legs of the V

"are simply conductors of carbon, which 7409 "might perfectly well, so far as the only "function that they perform is concerned, be "made of metal. Manifestly, therefore, this "lamp with the V-shaped carbon gives simply "a brilliant spot of light at the angle of the "V, and is not in the remotest manner an "equivalent for a carbon of horseshoe shape

"Adjourned to April 4, at 9:30 A. M.

7410

APRIL 4, 1889, 10 A. M.

"19 Q. Do you agree with the opinion ex- "pressed by Prof. Brackett in his answer to "question 36, that the primary advantage of "using the arch or loop form of conductor "in modern incandescent lamps is to allow of "great length of conductor?

"A. I do not. I understand that this form 7411 "is used chiefly because of the diminished "liability to straining and rupture from "changes in temperature or other causes. "The horseshoe form is certainly used in some "cases in which a straight filament of sufficient "length could be used without the least in- "convenience.

20 Q. Have you lamps of the kind you have "just referred to, and if so will you please 7412 "produce them?

"A. I have two such lamps, which I pro- "duce. One of these is a lamp made by the "Thomson-Houston Electric Company, of "Boston, which is used by them for run- "ning in series on the ordinary arc-light "circuits. It requires a current of a little

7413 "less than ten amperes to bring it to a proper "state of incandescence. The second lamp is "a Bernstein series lamp, also intended to be "used on arc-light circuits, and requiring a "current of about ten amperes. In both of "these lamps the filaments are quite short, "but have the usual arch-shape form.

"Complainant's counsel offers the
7414 "lamps referred to in evidence, and the "same are marked respectively Complainant's Exhibit Thomson-Houston "Lamp and Complainant's Exhibit Bernstein Lamp, H. C. M., Spe. Ex.

"21 Q. As a matter of fact, of what material have the incandescent conductors "of such incandescent lamps as have gone "into commercial use in this country since "1880, been made?
7415 "A. In all of them, without exception, carbon is employed. They do not, however, "in any case, make use of mineral carbon, "nor, so far as I am aware, has any attempt "been made to make use of mineral carbon in "a commercial lamp. In all of those incandescent lamps which have gone into practical use to any material extent, fibrous "carbon has been used in the fabrication of
7416 "the filament, and in all, with the exception "of a single style, the fibrous structure is "distinctly and evidently maintained.

"For example, the Edison lamp "employs a carbonized filament of bamboo; the Sawyer and Man lamp "uses a filament of carbonized bamboo; "the Maxim lamp a filament of carbonized

"paper; one of the United States Company's 7417
"forms of lamp also employs a filament of carbonized paper; the Swan lamp employs a "filament of cotton which has been parchmentized; the Westinghouse lamp employs "a filament of silk that has been parchmentized. The only lamp which is or ever has "been in commercial use, and which does not "show an evident fibrous structure, is a form "of lamp recently made by the United States 7418
"Company, which is made of tamadine, a material not known prior to 1880. Tamadine "is made by dissolving cellulose in some suitable solvent, as in making ordinary collodion, "and the cellulose is then percipitated in a "gelatinous state. From this the filaments "are cut and afterwards carbonized. This "mode of procedure of course obliterates the "evident, superficial, fibrous structure of the "material, but permits it to retain that ulti- 7419
"mate cellular structure which gives to "fibrous or textile material its peculiar value "for use in the filament of an incandescent "lamp.

"22 Q. Does the process of parchmentization to which you have referred, as used in "the process of making some of the filaments, "destroy the fibrous structure of the material?
"A. It does not; it merely serves to consoli- 7420
"date the material, and make it denser and "more uniform.

"23 Q. Are you familiar with the lamps "referred to by Prof. Brackett in his answers "to question 31 and cross-questions 67-72 inclusive, re-direct question 116, and re-cross

7421

" questions 130-132, and have you taken these
" lamps into account in your answer to ques-
" tion 21?

" A. I am familiar with the lamps referred
" to, and did take them into account in my
" last answer. The Bernstein lamp, which I
" did not refer to in my answer to the 21st
" question, employs a filament of woven silk.
" The citrite and luminoid lamp makes use
7422 " of a filament the precise preparation of which
" I do not know, and which I understand is
" not made public; it is however fibrous in
" its character.

" 24 Q. Please read Mr. Edison's answer to
" question 437, and state how far you took
" into consideration in your answer to ques-
" tion 21, the various processes of making car-
" bon there referred to by Mr. Edison?

7423 " A. In making that answer I had in my
" mind most of the processes referred to by
" Mr. Edison. I am not familiar, however,
" with the use of melassic acid or of the arti-
" ficially made chemical, to which he refers in
" that answer. All the other processes men-
" tioned by Mr. Edison in the answer referred
" to were in my mind when I answered the
" 21st question.

7424 " 25 Q. Have lamps having conductors made
" of a solution of melassic acid, or of the chemi-
" cal compound, or artificially-made chemi-
" cal referred to by Mr. Edison, gone into
" commercial use at all, so far as you know?

" A. Not at all, so far as I have any knowl-
" edge.

7425

" 26 Q. Has the carbonized fibrous or tex-
" tile material of complainant's patent in suit
" any special advantages over other forms of
" carbon for use as an incandescing conductor
" for an electric lamp; if so, in what do these
" advantages consist?

" A. It has, as is clearly indicated in that
" patent.

" Thus, by the use of material of this char-
" acter, it is possible to obtain a carbon con- 7426
" ductor of exceedingly great purity, and of
" evenness of texture throughout; so that the
" conductor will be free from spots, having a
" greater or less density than that of the
" conductor as a whole, a defect which when
" present is a very serious one. Such carbon,
" moreover, besides its evenness of structure,
" possesses in virtue of its cellular structure a
" high resistance in proportion to its
" length and section, or what is tech- 7427
" nically called a high specific resist-
" ance. This is an extremely desirable prop-
" erty in such a filament, inasmuch as, for a
" given strength of current and for a conduc-
" tor of given length and section, the heating
" effect is proportional to the specific resist-
" ance, so that, to derive a great amount of
" light from a filament of given size it is desir-
" able that its specific resistance should be
" high. This is a well recognized fact in in- 7428
" candescent electric lighting. Also, fibrous
" carbon is particularly fitted to undergo such
" treatment after carbonization as is found
" desirable in order to harden it and give to
" it a uniform and definite resistance, which
" is referred to in the patent as its 'suscepti-
" bility to tempering.' This tempering may

7429 " be done by treatment with hydro-carbons,
" or by carrying a strong current through the
" conductor *in vacuo*, raising it to high incan-
" descence, or by both of those methods com-
" bined. Moreover, the carbon of complain-
" ant's patent in suit is naturally firm, elastic
" and tough. Still more, the carbon of the
" patent has the great advantage of readily al-
" lowing the conductor to be shaped and
" given the proper dimensions before carbon-
7430 " ization, which is a most desirable charac-
" teristic. This facility for shaping before
" carbonization also, of course, carries with it
" the ability to predetermine approximately
" and before carbonization the resistance
" which the conductor is ultimately to have.
" These are the principal advantages that oc-
" cur to me as being possessed by the fibrous
" carbon of the complainant's patent.

7431 " 27 Q. Mr. Edison seems to be of the
" opinion that while the quality of high
" specific resistance, to which you have re-
" ferred, is desirable for lamps of very high re-
" sistance, and intended to be used in parallel
" or multiple arc, it is no advantage for in-
" candescent lamps of comparatively low ab-
" solute resistance, intended to be used in
" series; do you agree with him in this opin-
7432 " ion? Please read Mr. Edison's answers to
" questions 432, 467–470, inclusive, and give
" your reason for any opinion you may ex-
" press?
" A. I find myself forced to disagree
" with Mr. Edison in this matter, as it ap-
" pears to me that there can be no possible
" doubt that a high *specific* resistance is in

" itself desirable in any form of incandescent 7433
" lamp whatever, whether the lamp be in-
" tended for working in parallel or multiple-
" arc, or in series. As I have already pointed
" out, for a given current the heating effect in
" the lamp, other things remaining the same,
" is proportional to the specific resistance of
" the incandescing conductor. Now the total
" amount which is utilized of the electrical
" energy furnished by the dynamo machine is 7434
" that which is spent in heating the incan-
" descent conductor, and hence, the higher
" the resistance of this in proportion to the
" resistance of the rest of the circuit, the
" greater will be the fractional part of the
" total energy which is usefully employed in
" heating the conductors in the lamps, and
" other things remaining the same, if the
" specific resistance is high, the same absolute
" resistance of the lamp may be employed, al- 7435
" though a shorter and stouter carbon is
" used, which is in itself a distinct advantage,
" as such a carbon is more easily obtained.

" 28 Q. In your answer to question 26
" you refer to certain treatment which may
" be used for tempering an incandescent con-
" ductor made of carbonized fibrous or textile
" material; was this treatment, in both of the
" forms you have referred to, known in the 7436
" art as applicable to carbon conductors of
" other kinds prior to 1880?
" A. It was well known. I find a de-
" scription of the hydro-carbon process in
" U. S. patent to Sawyer and Man, No. 211,
" 262, dated Jan. 7, 1879, and a description
" of the tempering by heating in U. S. patent

7437

"to Sawyer and Man, No. 210,809, dated "Dec. 10, 1878.

"Complainant's counsel offers in evi- "dence the Sawyer and Man patent 211, "262 referred to, and the same is marked "Complainant's Exhibit Sawyer and Man "Hydro-Carbon Treatment Patent, H "C. M., Spe. Ex.

7438 "29 Q. Has the fibrous carbon of the "patent in suit any greater susceptibility to "or fitness for the processes of tempering to "which you have referred, than the forms of "carbon used in incandescent lamps prior to "1880?

"A. It has, owing to the fact of its porous "cellular structure, which in the hydro-car- "bon treatment allows that material to pene- "trate the conductor throughout, so that the "deposit of carbon thus made is not a purely
7439 "superficial one, but such as to influence the "entire structure of the carbon; while in the "treatment by heating, the fibrous structure "allows of the ready expulsion of gases from "the whole interior of the filament.

"30 Q. To what extent and for what pur- "poses have these processes been used in "the manufacture of incandescent lamps since "1880?

7440 "A. As far as I am aware, the process of "heating to a high temperature has been and "is used with all incandescent lamps, while "the hydro-carbon treatment has been applied "to all with the exception of a very few. "The hydro-carbon treatment is employed to "give uniformity of resistance throughout "the filament itself, and to bring the fila- "ments of individual lamps to a given stand-

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"ard resistance, thus healing the defects "incident to the manufacture of the filament, "and allowing the employment of very many "filaments which, without the use of this "process, would have to be rejected, avoiding "the peculiarities of the individual filaments, "and causing them to approach more nearly "to the condition of the ideal filament, such "as would be furnished by a perfect fibrous "or textile material. The extent to which "the hydro-carbon treatment is carried is 7442 "different with different kinds of lamps, "differing with the material used by the "various makers.

"31 Q. Mr. Edison, in his answer to ques- "tion 54, appears to be of the opinion that "when the hydro-carbon treatment is applied, "the character of the carbon conductor used "for such treatment is wholly immaterial, "and that it makes no difference what kind 7443 "of carbon is used for this purpose, or even "if a metal is used. Do you agree with him "in this opinion, and would such a result "follow from the use of hydro-carbon treat- "ment, as applied in the commercial manu- "facture of incandescent lights?

"A. I do not agree with Mr. Edison in the "opinion referred to in the question. The "hydro-carbon treatment, as I understand it, 7444 "is intended to remedy defects in the natural "fibre, as I have already explained, but not "to supersede the original fibre. This is ap- "parent from the fact that so much ingenuity "has been spent in obtaining a suitable fila- "ment to begin with, although the hydro- "carbon treatment was to be subsequently

7445 "applied. Moreover, great care has to be
"taken in the original selection and carboni-
"zation of the filaments, which otherwise
"fail notwithstanding that they have been
"subjected to treatment. As I understand
"the ordinary use of the hydro-carbon pro-
"cess, the filaments are usually treated only
"to a moderate or even slight extent, and not
"so as to destroy or render useless their origi-
7446 "nal structure. That is, the original structure
"does not become, as Mr. Edison seems to
"suggest, a mere sort of scaffolding which
"supports the deposited carbon, but still re-
"mains an essential or indeed the essential
"portion of the whole conductor.

"Adjourned till 2 P. M.

"Resumed 2 P. M.

7447 "32 Q. Would any of the forms of carbon
"of the incandescent lamps described in the
"prior patents and publications put in evi-
"dence by defendant, have the characteristics
"you have described, in your answer to ques-
"tion 26, as possessed by the carbonized
"fibrous or textile material of the complain-
"ant's patent in suit?

"A. They would not. In my opinion, there
"is not one of them which, even with the var-
"ious improvements that have been made up
7448 "to the present time, would be capable of
"commercial use for electric lighting.

"33 Q. Prof. Brackett states in substance.
"in his answer to question 5, that the con-
"struction of the bottom plate of the lamp
"chamber of glass, and that of the dividing of

7449
"the two parts by a ground joint, as shown
"and described in the patent in suit, was old
"in the art of incandescent lighting. Do you
"find this construction, or its equivalent, de-
"scribed or shown in any of the prior patents
"or publications put in evidence by the de-
"fendant, except the two prior patents of
"Sawyer and Man? Please read in this con-
"nection Prof. Brackett's answers to cross-
"questions 50-52, and cross-question 64; also 7450
"Prof. Barker's answers to questions 10, 17,
"and cross-questions 58-61.

"A. With the exception of the prior pat-
"ents to Sawyer and Man, I do not find the
"construction in question, or an equivalent
"construction, in any of the prior patents or
"publications put in evidence by the defen-
"dant.

"Prof. Brackett and Prof. Barker refer to
"the English patents to Staite and Kosloff, 7451
"and to the United States patent to Kosloff,
"as embodying the particular construction set
"forth in the Sawyer and Man patent in suit.
"I fail to find any such construction in these
"patents.

"The lamp described and figured by Staite
"employs a strip of metal for an incandescent
"conductor, which is covered by a sort of
"shade, presumably to screen it from the air.
"This shade rests upon a support, and a 7452
"block of glass, or some similar bad conduc-
"tor of heat, closes the mouth of this globe.
"The object of this block of glass is stated to
"be to aid in keeping up the temperature of
"the incandescent conductor. The globe
"covering the metal strip is filled with air at
"the ordinary density, there being no need

7453 "of removing it, or replacing it, by an inert "gas. The block of glass is not used as a "stopper to prevent any perceptible ingress "or egress of air, but merely serves to close "the mouth of the receiver. The Kosloff "patents show a receiver containing the in- "candescing pencils which are inclosed in an "atmosphere of nitrogen. The bottom of "this receiver, however, is made tight, not by
7454 "means of a glass plate or stopper, but by a "hydraulic sealed joint.

"Defendant's experts also refer to Roberts "British patent of 1852, but there is no de- "scription whatever of the material of which "the cap closing this lamp was to be made, "and from the appearance of the figure, as "well as from the custom of that time, I "should infer that the cap was made of "metal. Defendant's experts refer to cer-
7455 "tain devices in which ground metal plates "were made use of, considering these as the "complete equivalent of a glass plate. I do "not agree with them in this view since the "coefficient of expansion of metal is so very "different from that of glass that the use of a "metal stopper or metal plate would unques- "tionably cause difficulty on this account, "and the comparative rapidity with which "the metal would heat or cool, as compared
7456 "with glass, would be a further cause of dif- "ficulty. It seems to me that the use of the "glass plate or stopper is entirely novel with "Messrs. Sawyer and Man.

"34 Q. Defendant's experts have expressed "the opinion that the lamp structure of the "complainant's patent in suit has all the de- "fects of the lamp structures of incandescent

7457 "lamps described in the prior patents and "publications in evidence; and that the lamp "structure of the patent in suit would be "wholly unsuitable for maintaining with suf- "ficient stability any definite condition of the "atmosphere within it, whether a vacuum or "non-combustion-supporting gas, to make "the lamp a practically useful structure for "the purpose of electrical illumination; and,
"moreover, that the low resistance of the in- 7458 "candescent conductor would make the lamp "practically useless. Do you agree with "them in this opinion? Please consider, in "this connection, Prof. Brackett's answers to "questions 12, 15, 28, and cross-questions 74- "78; Prof. Barker's answers to questions 11 "and 12; Mr. Edison's answer, to question "61, cross-questions 306-337, questions 402- "405, 476, 478, 479, cross-questions 507- 7459 "515.

"A. I do not agree with defendant's ex- "perts in the opinion which they have express- "ed. The lamp structure which is set forth in "complainant's patent in suit employs as its "conductor carbonized fibrous or textile "material, which, as I have already pointed "out, possesses the greatest advantages over "such materials as I have mentioned before.
"It is true that the dimensions of the parti- 7460 "cular conductor shown in the figures of that "patent are such that it would have a low "absolute resistance, and hence that it would "require only a low electro-motive force to "furnish the somewhat strong current requi- "site to bring it to a proper state of incan- "descence. It seems to me, however, that

7461 "defendant's experts are entirely in the
"wrong in assuming that because of these
"facts the structure would make 'a lamp
"that would not be practicable.' My quota-
"tion is taken from Prof. Brackett's answer
"to question 12. It is quite true that any
"lamp possessing such a low resistance would
"not be suited for use over considerable dis-
"tricts in a parallel system of illumination;
7462 "but, on the other hand, it is in this respect
"exactly the kind of lamp that is wanted for
"use in a series system, and in fact lamps
"of low resistance and adapted to run in
"series are now customarily made and em-
"ployed."

"So far as the other matter referred to by
"defendant's experts is concerned, that is,
"the liability to leakage, there is no doubt
"that the method devised by Sawyer and
7463 "Man, like every method that has been de-
"vised, is subject to certain imperfections;
"and I do not doubt that for general use on a
"large scale some other methods are prefer-
"able, since a multitude of persons have been
"at work upon this subject since 1878, and
"numerous improvements have been devised.
"But I am confident that the structure of the
"lamp of complainant's patent in suit is such
"that, notwithstanding the fact that it is not
7464 "an absolutely perfect structure, it is fitted
"for practical commercial use. I do not
"mean by this that the lamp of the Sawyer
"and Man patent would be able to compete
"commercially with gas, which appears to be
"Mr. Edison's test of the practical usefulness
"of an incandescent lamp, or that it would
"meet the requirements for a commercial in-
"candescent lamp laid down by Prof. Brackett

"in his answers to questions 71–78. Indeed, 7465
"the standard (1,000 hours) which Prof.
"Brackett sets up as necessary that a lamp
"be 'practically useful,' is far above that
"which, as I am informed, any of the com-
"panies manufacturing incandescent lamps
"are at present willing to guarantee. Nor do
"I think that it would be able to compete
"commercially with more recent and im-
"proved forms of incandescent lamp, upon 7466
"which a great wealth of experimentation
"has been lavished. But I am very confi-
"dent that if we had no better system of in-
"candescent lamp, this would have a distinct
"commercial value for many purposes. And
"I am sure it could be made sufficiently last-
"ing to be of decided use. For ex-
"ample, I think there can be no question
"that a lamp of this construction could be
"made to last as many as fifty or one 7467
"hundred hours, and such a lamp would
"certainly be of value for practical purposes.

"I do not agree with defendant's experts
"that the lamp structure of complainant's
"patent in suit has all of the defects of the
"lamp structures set forth in the prior pat-
"ents and publications in evidence. The
"use of a stopper of glass or a plate of glass,
"ground to the receiver as described in the
"patent, would very greatly diminish liabil- 7468
"ity to leakage, and materially prolong the
"life of the lamp.

"35 Q. Defendant's experts express the
"opinion that the inventors, Sawyer and Man
"made no substantial advance in the art, or
"at least none that is shown and described

7469 " in the patent in suit. Do you agree with
" them in this opinion? I call your attention
" particularly, to Prof. Brackett's answer to
" question 5, and Prof. Barker's answer to
" question 9.

" A. I do not agree with Professors Brack-
" ett and Barker in regard to this. On the
" contrary, I find set forth for the first time
" in the Sawyer and Man patent in suit the
7470 " use of carbonized fibrous or textile material
" in general, as the incandescing conductor
" of an electric lamp, and also of the use of
" such conductor in a horseshoe shape. As
" I have stated in answers to previous ques-
" tions, I regard these as important improve-
" ments over anything that had been done
" before, and I am confident in this opinion,
" since these are used in all modern incandes-
" cent lamps. The use of the particular form
7471 " of carbon referred to, in addition to the ad-
" vantages of structure and character, allows,
" as I have already explained, the shaping of
" the material prior to carbonization, which is
" an advantage that cannot be overestimated,
" and of which substantially all manufactur-
" ers of incandescent lamps have availed them-
" selves. In fact, in this patent, Messrs. Saw-
" yer and Man have supplied a carbon pos-
" sessing those peculiar qualities which have
7472 " made modern incandescent lighting a pos-
" sible thing, and such carbon is actually em-
" ployed in all, or nearly all incandescent
" lamps which are in commercial use.

" Adjourned to New York, at the office of
" Duncan, Curtis & Page, April 5, at 10:30
" A. M.

7473
"NEW YORK, April 5th, 1889.

" Met pursuant to adjournment. Present
" counsel as before.

" *Direct Examination of* PROF. CROSS *continued as,*
" *follows*:

" 36 Q. Do you agree with the opinion
" expressed by defendant's experts that there
" is no novel or useful invention described in
" the first claim of complainant's patent in
" suit? Please read Prof. Brackett's answers
" to question 6 and cross-questions 37-43, and 7474
" Prof. Barker's answers to question 14 and
" cross-questions 53-55.

" A. I do not agree with defendant's ex-
" perts in the statements referred to in the
" question. The first claim of the patent in
" suit sets forth the use of a peculiar material,
" namely, carbonized, fibrous or textile
" material, which is to be given a horseshoe
" shape.

" The material of the incandescing conductor 7475
" set forth in this claim is entirely new and
" not found, in my opinion, in any previous
" incandescent lamp; and there are, moreover
" as I have already explained, advantages in
" the use of the arch shape with this material
" which do not exist with the metal conduc-
" tors with which alone it had previously
" been employed. The form of carbon set
" forth in the claim, that is, carbon made by
" carbonizing fibrous or textile material, 7476
" posseses, as I have already explained, many
" marked advantages over such carbon as had
" previously been suggested for use in incan-
" descent lamps. Fibrous or textile material
" possesses the special advantage of being
" adapted for shaping before carbonization

7477 "a feature which is of the greatest value in "the manufacture of an incandescent lamp. "Moreover, as I have explained in previous "answers in this deposition, there is a "material advantage given to the lamp by the "use in it of a conductor of horseshoe shape, "in that this can adapt itself to variations of "temperature which would cause a rupture of
7478 "a straight filament of carbon, although with "metal this is not a matter of any importance. "It appears to me that the first claim of the "patent in suit sets forth a distinctly new "invention which did not previously exist, "either in the exact form set forth in the "patent in suit or in an equivalent form.

"37 Q. Do you agree with the opinion "expressed by defendant's experts that there "is no novel or useful invention described in
7479 "the second claim of the patent in suit? "Please read Professor Brackett's answers to "question 8, and cross-questions 43 to 49, "and Professor Barker's answers to question "16 and cross-questions 56 and 57.

"A. I do not agree with defendant's experts "in their conclusion with regard to this claim. "It seems to me that they overlook the fact "that there is an entirely new element which "enters into the combination therein set "forth; namely, that the incandescing carbon
7480 "conductor is made of 'carbonized fibrous "material,' so that the combination set forth "in the claim is itself new. It does not ap- "pear to me that the lamps referred to by de- "fendant's experts as anticipating the struc- "ture set forth in this claim really do so, "for reasons that I have explained at some "length in a previous answer. "I know of "no lamp prior to that set forth in complain-

"ant's patent in suit which contains the com- "bination set forth in this second claim. 7481

"38 x-Q. Do you agree with the opinion "expressed by defendant's experts that there "is no novel or useful invention described in "the fourth claim of the patent in suit? "Please read Professor Brackett's answers to "question 9 and cross-questions 50 to 52, and "Professor Barker's answers to question 17 "and cross-questions 58 to 61. 7482

"A. I do not agree with their opinion in "this matter. The fourth claim referred to "is for a combination of elements one of "which, the illuminating conductor, made of "carbonized fibrous or textile material, is en- "tirely new, which, therefore, gives an en- "tirely novel combination. Still more, as I "have already explained at length in previous "answers, the lamp structure set forth in this "claim is one better adapted for preserving 7483
"a stable condition of the vacuum, or atmos- "phere of inert gas, within the hermetically "sealed chamber. And this last fact is of im- "portance in its relation to the peculiar kind "of carbon used for the conductor. Such "fibrous carbon needed a better protection "than the hard gas carbon which had pre- "viously been used as a conductor in incan- "descent lamps, inasmuch as it is more readily "destroyed by the action of oxygen. * * * 7484

"44 x-Q. Do you agree with the opinion "expressed by defendant's experts that there "is not a sufficient description in the specifi- "cation of the patent in suit as to the charac- "ter of the fibrous material to be used for the "burner, its selection, its preparation for car- "bonization, and its carbonization, to enable

7485 "others generally skilled in the art as it ex-
"isted at the date of the application, viz:
"January 9, 1880, to produce a practically
"operative incandescent conductor without
"experiment? Please read Prof. Brackett's
"answers to questions 16 and 19, inclusive
"cross questions 55 to 63 inclusive; also
"Prof. Barker's answers to questions 22 to
"27 inclusive and cross-questions 66 to 85,
7486 "inclusive; also Mr. Edison's answers to
"questions 418 to 429 inclusive, 433 to 435,
"inclusive, 439 to 441 inclusive, 449 to 564½
"inclusive, and give your reasons for any
"opinions that you may express. I also call
"your attention to Mr. Edison's answers to
"questions 25 and 26.

"A. I do not agree with defendant's ex-
"perts in their opinion that the Sawyer and
"Man patent in suit is defective in the mat-
7487 "ter referred to in the question. The patent-
"ees direct the use of carbonized fibrous or
"textile material and state that they have
"used carbonized paper and also wood car-
"bon. With regard to the use of the first of
"the materials mentioned, I think there is
"no possible question that one wishing to
"make use of the invention described in the
"Sawyer and Man patent would have known
"how to proceed in order to procure a paper
7488 "suitable for his purposes. He would natu-
"rally have assumed that a pure paper was
"desirable, and so would have rejected pa-
"pers which were loaded with mineral matter
"or with size and similar materials. He
"would also have sought a paper of even tex-
"ture. I am confident that at the date of
"the application for the patent in suit and

"for many years before as well as since, pure 7489
"paper could readily be procured in the market.
"For example, Bristol-board is a kind of
"paper that was well known to be pure in
"quality and even in texture and which, I
"think, one would naturally have selected
"for the purpose. Blotting paper is another
"well known variety which could be ob-
"tained in a state of purity. Still more,
"there were various processes by the use of 7490
"which the adulterants employed in the manu-
"facture of paper could have been removed
"had such paper been employed. As a mat-
"ter of fact, paper has been largely
"and successfully employed in the manu-
"facture of incandescent lamps. Thus Mr.
"Edison, in that portion of his deposition
"referred to in the question describes his
"own employment of that material. Also,
"some of the types of lamp manufactured 7491
"by the United States Electric Lighting
"Company have been made of paper and
"have been very widely used and with satis-
"factory results.

"With regard to wood carbon, it seems to
"me that the directions in the patent are
"quite sufficient to have enabled one to util-
"ize this in a lamp of commercial value. I
"think that one reading the Sawyer and
"Man patent would have understood the term 7492
"'wood' in the sense in which it is defined
"by Prof. Barker in his answer to question
"22 as referring to

"'the material which constitutes the
"'stems of most, if not all, vegetable sub-
"'stances.'

"With this understanding he would doubt-

7493 " less have selected from among the various
" well known forms of woody tissue those in
" which the fibres were parallel, long and
" even. He certainly would not have limited
" himself to exogenous growths, but would
" include in his range the various endoge-
" nous plants. Also, he would probably have
" picked out a thread of cotton or other ma-
" terial of even texture and pure quality.

7494 " Having selected the material it would be
" necessary to determine upon its shape.
" There is no question that in the use of tex-
" tile material the shape would be determined
"prior to carbonization. Indeed, the very nature
" of such material in general, necessitates
" this and unquestionably implies it. If paper
" were the material selected, I cannot imagine
" that any one would fail to see the desirabil-
" ity and practical necessity of shaping it
7495 " before it was carbonized. It is already
" shaped in one dimension and would natu-
" rally be cut or stamped into shape while
" the paper was still uncarbonized and easily
" cut. This mode of procedure is infallibly
" suggested by the statements of the patent.

" As to the carbonization, the patent gives
" no special description, but contents itself
" with referring to the various well known
" processes of carbonization. And it does
7496 " this very properly, since the subject of car-
" bonization had been carefully studied and
" the methods whereby thorough, uniform
" and complete carbonization could be secured
" were perfectly well known to those skilled
" in the art.

" It is, of coure, true that in one desirous of
" practicing the invention under consideration

" an exercise of common sense, good judgment 7497
" and technical information would be neces-
" sary in order to exclude unsuitable and
" select suitable materials for the purpose,
" and undoubtedly experience would show
" one that certain of the various materials
" selected were much better adapted to the
" purpose than others, but, in my opinion, all
" this would involve simply the ordinary skill
" of the artisan and not the ingenuity of the
" inventor. 7498

" The same remark applies to the subse-
" quent process, as of carbonization.

" I think there can be no possible question
" that one familiar with the state of the art
" at the date of the application for the Sawyer
" and Man patent in suit, by the exercise of
" existing knowledge, employing only the
" skill of the trained artisan, and without in-
" vention, would have been able to construct
" an incandescent lamp which would serve a 7499
" useful purpose and have a commercial value.

" 45 Q. Would it, in your opinion, have
" required experiment on the part of a person
" skilled in the art as it stood prior to 1880,
" to reach the conclusion expressed by Prof.
" Barker in his answer to question 27 that a
" carbon conductor made from a strip cut
" across the grain or fibre of wood would be
" useless for incandescent lighting?

" A. In my opinion, it would not. 7500

" 46 Q. Would it have required experi-
" ment to ascertain the defects stated by Prof.
" Barker in his answer to question 25, of car-
" bon formed by cutting blanks of arch form
" from wood in such a manner that the fibres

7501
"were cut across in a part of the length of
"the conductor?
"A. It would not. This fact was per-
"fectly well known.
"47 Q. Do you think any person skilled
"in the art as it stood prior to 1880 would
"have attempted to make carbons in that way
"if he were merely told to use carbonized
"fibrous or textile material for the conductor
7502 "of a lamp?
"A. I should not think it possible that
"he would have done this. Such a procedure
"is not at all that which is suggested by the
"direction.
"48 Q. What would such a person have
"known to be requisite with respect to uni-
"formity of resistance in the conductor of an
"incandescent lamp, and what would this, in
"your opinion, have necessarily implied to
7503 "such a person in the selection and prepara-
"tion of the material before carbonization?
"A. He would have known that the resist-
"ance of the conductor should be as nearly
"as possible uniform throughout. This would
"have led him to select fibrous material or
"fibres which were continuous and which
"would not be cut or broken in shaping.
"49 Q. If such a person desired to make
"a conductor in an arch form from carbon-
7504 "ized wood, what would, in your opinion,
"have been the method of making it which
"would most readily have occurred to him
"with no further instructions than those
"stated in question 47?
"A. It seems to me that it would nat-
"urally have occurred to him to make use of
"the long fibres of some of the different
"varieties of grass or reeds, or perhaps the

7505
"woody leaves of some plants, or probably
"some fibrous bark. I think he would have
"selected such a fibre, bent it into shape and
"keeping it in that condition would have sub-
"jected it to thorough carbonization.
"50 Q. Do you think that a person
"skilled in the art as it stood prior to 1880
"and desiring to succeed in producing a very
"slender filament from carbonized fibrous or
"textile material would select wood having 7506
"interlaced fibres and thereby encounter the
"difficulties referred to by Prof. Wilson in
"his answers to questions 19 to 23 inclusive?
"A. Certainly not. That would be the
"precise way not to do it.
"51 Q. Do you think he would select wood
"so resinous as to produce the defects re-
"ferred to by Prof. Wilson in his answer to
"question 24?
"A. I cannot imagine that he would do 7507
"this.
"52 Q. Do you think he would select veg-
"etable tissues merely because they could be
"readily cut although they would be practi-
"cally worthless for electrical purpose, or
"merely because the wood in itself was tough
"before carbonization, as is apparently as-
"sumed by Prof. Wilson in his answer to
"question 25?
"A. Centainly he would not do this. 7508
"53 Q. In your answer to question 39 you
"say that the defendant's experts assume that
"the conductor of an incandescent electric
"lamp is to be necessarily a hair-like filament,
"and that you find no such assumption in
"the patent in suit; would there be less diffi-
"culty in selecting proper fibrous or textile

7509 "material for making thicker conductors, as, "for instance, conductors approaching the "thickness of that shown in the drawing of "the patent in suit than in selecting proper "material for hair-like filaments.

"A. There would, unquestionably. Many "substances which would not furnish fine, "hair-like filaments of the quality necessary "for use in an incandescent lamp would be
7510 "amply sufficient if the conductor was to be "heavier.

"54 Q. What is the reason for this?

"A. There are many vegetable substances "which cannot readily be split into very fine "filaments, or which, if so split, are too brit- "tle to give satisfaction, which will neverthe- "less furnish filaments of larger section.

"55 Q. In your answer referred to you "also say that there were processes of treat- "ment well known, by means of which mate-
7511 "rial, which might otherwise be unsatisfactory, "could readily be made suitable for practi- "cal use. To what processes did you "refer?

"A. I had in mind that consolidation of "the carbon which occurs when occluded "gases are driven from it on raising it to a "high state of incandescence, by carrying a "heavy current through it, and especially the "beautiful process of hydro-carbon treatment
7512 "which was also devised by Messrs. Sawyer "and Man. In this latter process the filament "is carried to incandescence by passing a "heavy current through it while surrounded "by an atmosphere of hydro-carbon vapor. "The vapor is decomposed and carbon depos- "ited most abundantly wherever the heating

"is greatest. And as such heating is necessa- 7513
"arily most pronounced at those points in the "lamp which are defective, carbon is most "abundantly deposited at those points, thus "healing the faulty places in the lamp. This "process is so valuable that it is employed "with most types of lamp to-day.

"56 Q. Are these the processes to which "you refer in your answers to questions 26 to "28? 7514

"A. They are.

"57 Q. Would the use of these processes "materially increase the proportion of fibrous "and textile materials which would be avail- "able for making practically useful incandes- "cent conductors for electric lamps?

"A. They would very greatly increase the "number of such materials.

"58 Q. In selecting endogenous stems do
"you think that a person skilled in the art 7515
"as it stood prior to 1880, would select mate- "rial which would produce the undesirable "results set forth in Prof. Wilson's answer to "Q. 28?

"A. On the contrary I should suppose that "he would endeavor as far as possible to avoid "the use of endogenous material in which "these characteristics are prominent.

"59 Q. When translated into common lan-
"guage what is the substantial meaning of 7516
"Prof. Wilson's disquisition on the structure "of bamboo stem contained in his answers to "questions 29 to 32 inclusive?

"A. As I understand Prof. Wilson's state- "ments referred to, the structure of bamboo "is identical in its nature with that of other "endogenous plants, but that a certain kind

7517 "of tissue, the bast cells are so compacted "and joined together as to give a very homo- "geneous filament which particularly fits it fo "use in an incandescent lamp.

"60 Q. Is there any other peculiarity of "bamboo which makes it peculiarly suitable "for making very slender filaments?

"A. Of course its fibrous structure as a "whole particularly fits it for this purpose "and the special portion of the stem referred
7518 "to by Prof. Wilson presents these character- "istics in a very marked degree.

"61 Q. Were these peculiarities of bamboo "known prior to 1880?

"A. They were, all of them, as I under- "stand the matter. Certainly its fibrous "character and the facility with which it "could be split into fine uniform fibres had "been known for an indefinite period.

* * * * *

7519 "68 Q. Is it true as stated in the final "specification that methods of carbonizing "material while confined in retorts in pow- "dered carbon were in practice before the "filing of the application for the patent in "suit?

"A. It is true.

"69 Q. Was this method well known and "had it been used in the art of electric light-
7520 "ing prior to the filing of the application for "the patent in suit?

"A. It was well known and had been so "used.

* * * * *

'79 Q. Do you agree with the opinion ex- "pressed by Prof. Barker in his answer to "question 50?

"A. I do not. The Gaudoin patent 7521 "describes a process of making carbon pen- "cils for use in electric lighting, which term "at the date of the original patent was used "only as referring to arc lighting, although "later Gaudoin's carbons were used experi- "mentally in some arc incandescent light. "The whole process which Gaudoin describes "is adapted and professes to be adapted to "produce a hard and compact carbon pre- 7522 "cisely such as was suited for arc lighting "carbons, and not at all that which is adapted "for incandescent lighting. That is, the "pitch, resin and bitumen used in the origi- "nal patent or the wooden object impregnated "with these or other similar materials which "are referred to in the certificate of addition "are totally different things from the fibrous "carbon set forth in complainant's patent in "suit. The aim of the Gaudoin patent was 7523 "to make pencils possessing the characteris- "tics of pencils of gas carbon, an end which "other inventors prior to Gaudoin had also "sought to obtain. It seems to me that there "is nothing in the Gaudoin patent which "would in any way guide a person to use "such carbon as he is taught to use by com- "plainant's patent in suit.

"Prof. Barker is incorrect in his statement "that the Gaudoin pencils 'not over a milli- 7524 "metre or two in diameter' were 'adapted "only to the production of light by incandes- "cence.' They were adapted to be used, and "in fact, were used in arc incandescent "lamps. It would of course have been pos- "sible to use them instead of gas carbon "pencils in such an incandescent lamp as

7525 "that shown in Jensen's British patent No. "970 of 1875, but if they were to be so used "they would possess no properties superior "to or different from those of the hard gas "carbon pencils made for the same purpose.

"81 Q. Do you agree with the opinion ex- "pressed by Prof. Brackett in his answers to "re-direct questions 119 and 120, that there "would be no difference in the relative value
7526 "for electric lighting purposes between the "lamp described in the patent in suit, and "that of the prior patents of Roberts, Shepard, "Konn, Kosloff and others to which he has "referred, as anticipating the claims of the "patent in suit?

"A. I do not. It seems to me that the "lamp of the patent in suit would possess a "value much greater than that of any of the "prior lamps.

7527 * * * * *

"133 x-Q. When was the arc lamp first in- "troduced extensively for commercial use, if "you know?

"A. The arc lamp began to be employed "for special purposes about 1845. After "1854, or thereabouts, it was used to an in- "creasing extent, for light-house illumination. "After 1873, or thereabouts, and to a certain
7528 "extent before this, it was employed more or "less in the illumination of dock-yards, build- "ings in process of construction, etc. Its "use, however, was quite limited. About "1876 or 1877, it began to be used for street "lighting, for which it has been extensively "used from 1878 onwards. Since the latter "date it has been very widely used.

"134 x-Q. Where were the early industrial "uses of the arc light made?

"A. It was used in some of the French 7529
"light-houses, and also in some of the English "light-houses as well. It was used, I believe, "in some of the French docks, and it was "used for lighting some of the streets of "Paris.

"135 x-Q. Was it used industrially, so far "as you know, say prior to 1853, except its "use for theatrical effects in Paris, as stated "by Fontaine in his work on electric lighting?

"A. I do not recall any specific instances 7530
"earlier than this. I think very likely it may "have been used, but only to a trifling extent. "I think it was sometimes used in illumina- "tions, and for like purposes." * * *

"197 x-Q. Was not arc lighting in its ex- "perimental stages in 1857?

"A. No; not for the purposes for which "it was employed. Of course, in relation to "our commercial use of arc lighting, what was "done then would be considered experi- 7531
"mental.

"198 x-Q. How large was the experimental "use of arc lighting in England in 1857?

"A. What I had in mind was the use of "the arc light in the theatre, and for illumina- "tions; also its use as a brilliant source "of light for optical purposes. It does not "seem to me that these uses are properly "called experimental, though of course its "use at that early date was very limited. If 7532
"one might judge by the number of patents "prior to 1857 which I find put in evidence "by defendants in this case, the matter of "arc lighting might be supposed to have "passed beyond a purely experimental "stage." * * *

7533

"205 x-Q. You have stated, in answer to
"question 79, and with reference to the Gau-
"doin carbon pencils of the smallest sizes,
"that they were "adapted to be used, and in
"fact were used, with arc incandescent lamps,"
"do you mean that they were not used in in-
"candescent lamps?

"A. I cannot say as a matter of fact that
7534 "they were not used at all in incandescent
"lamps; they may have been so used; but
"there is no evidence so far as I know that
"such was the fact. What I particularly
"wished to indicate by my reference to their
"use in arc incandescent lamps was the falla-
"cy of the assumption made by Prof. Barker
"that 'some of them being not over a milli-
"metre or two in diameter, were, therefore,
"adapted only to the production of light by
7535 "incandescence.' That is, Gaudoin describes
"specifically a process intended for the pro-
"duction of hard carbon pencils for use in
"arc lighting. Some of these pencils were
"made small in diameter. Prof. Barker con-
"cludes from this, and from this only, that
"these could have been used only for incandes-
"cent lighting. As a matter of fact, they were
"better adapted for arc incandescent lighting
"and moreover they were actually used for
"that purpose. I only wanted to point out
7536 "that Prof. Barker's conclusion in this matter
"was not justified by his premise.

"206 x-Q. You did not intend, then, by
"answer to question 79, to exclude the idea
"that such carbons were in fact used in in-
"candescent lamps?

"A. I did not. I cannot say but that they
"may have been used, but do not recall any
"evidence that such is the case.

"207 x-Q. You feel quite certain, however, 7537
"that they were used in arc incandescent
"lamps?

"A. That is my understanding.

"208 x-Q. What evidence of that fact did
"you have in mind at the time of making
"your answer to question 79?

"A. I recalled having seen a statement in
"some book on electric lighting to that ef-
"fect. My impression is that there is a refer- 7538
"ence to it somewhere in Higg's book.

"209 x-Q. If it should appear as a matter
"of fact that these small Gaudoin pencils
"were used in incandescent lamps, would
"you change your views as to the intention
"of Gaudoin in making them?

"A. If they were merely used experimental-
"ly or occasionally for that purpose, this
"would not modify my opinion in that re-
"gard. If they were used habitually and in 7539
"large quantities, I think it would be fair to
"conclude that they were made at least in
"part for that purpose.

"210 x-Q. Do you think they were used
"more than experimentally or occasionally for
"arc-incandescent lamps?

"A. I cannot say. Of course, in a sense,
"the arc-incandescent lamps themselves were
"experimental, so that the same would be
"true with regard to any special size of car- 7540
"bons made for them.

"211 x-Q. Do you not think that the fact
"as to the use of these carbons is the best
"test of the purpose for which they were in-
"tended?

"A. Yes, that seems to me to be a fair con-
"clusion, assuming, of course, that the use

7541 "was sufficiently extensive to demand the "construction of such material.

"212 x-Q. You state, in answer to cross-question 205, that, 'as a matter of fact, they were "'better adapted for arc-incandescent light- "'ing'—do you mean by this that in 1877, "when these Gaudoin pencils were made, the "character of carbon best adapted for incan- "descent lighting was understood?

7542 "A. I did not intend to be understood as "saying this.

"213 x-Q. That statement was made, then, "I take it, from your present information as "to the desirable characteristics of such a "carbon?

"That is true to a certain extent. My "statement, however, was made with re- "ference not so much to the material of "which these small carbons were made as to "their dimensions. I was doubtless guided 7543 "by my present knowledge in making that "answer. As a matter of fact, however, "although we are discussing these Gaudoin "pencils as though they were regular and "well-known articles of commerce, the only "definite statement with regard to them which "I find anywhere in this case is the state- "ment of Prof. Barker, in his answer to the "50th question, that he knows, apparently 7544 "from having seen them, that these pencils "were made of various sizes, some large and "some small, even not over a millimetre or "two in diameter. There is nothing in this to "show that these small pencils were other than "samples shown at some exhibition merely "as illustrative of the process. Still further, "Prof. Barker does not say that the pencils

7545 "which he saw were intended for the produc- "tion of any kind of a light by electricity, "and, so far as I can see, these particular "pencils may have been intended not for "electric lighting, but for some of the other "purposes for which, as stated by him in "his patent, Gaudoin made pencils of carbon.

"214 x-Q. What is there in the dimen- "sions of these small carbons that would 7546 "make them ill-suited for use in incandes- "cent electric lighting?

"A. I don't think that I have made the "statement that they were ill-suited for incan- "descent electric lighting, but that they were "better suited for arc-incandescent lighting. "These pencils, especially if they have the "diameter of two millimeters, are large for "incandescent lighting, unless their length "is very short, and if the length used is to 7547 "be very short, I should hardly think they "would be made in long pencils, or in rods "of sufficient length to have the name 'pen- "'cil' applied to them.

"215 x-Q. Should you think that a diam- "eter of 1.6 millimeters and a length of from "15 to 18 millimeters would be large for use "in incandescent lamps of the character "known in 1877?

"A. I think there is no doubt that some of 7548 "the incandescent lamps then devised were "intended to employ a carbon rod as large as "this, though I am not positive, in the ab- "sence of direct measurements.

"216 x-Q. Would a round pencil having a "diameter of 1.6 millimeters, and a length of "15 millimeters, be radically different in size

7549 "from the carbon for incandescent lamps, the "proportions of which are given for a small "form of lamp on page 99 of Sawyer's book "on Electric Lighting?

"A. It would not.

"217 x-Q. Would such a carbon pencil be "radically different in size from the size of "the carbon shown in Fig. 3 of the patent in "suit?

7550 "A. I should say not.

"218 x-Q. I understand that your opinion, "that the small Gaudoin pencils were used in "arc-incandescent lamps, is based, at least in "part, on some statement in Higg's transla-"lation of Fontaine's book, which has been "several times referred to in the course of "your examination. Please refer me to the "statement?

"A. It is based on a statement which I
7551 "have read, and which I think is somewhere "in Higg's book. I do not recollect where, "however, but should be glad to try and find "it. My own copy of Higgs is at present in "New York, so that I have no access to any "mark which might indicate its presence.

"219 x-Q. It is a fact, is it not, that the "methods of making the Gaudoin carbon pen-"cils, as well as carbon pencils of some other "makers, and also various tests of the carbon
7552 "pencils, are described in Chap. 3 of Higg's "translation and in Chap. 3 of the original "book of Fontaine's, both of which I now "hand you?

"A. That is the case.

"220 x-Q. It is also true, is it not, that in "Chap. XI. of each of the books referred to in "cross-question 219 the use of Gaudoin pen-"cils of small diameter in incandescent elec-

"tric lamps of the Konn construction is "described? 7553

"A. Reference is made to some laboratory "experiments with Konn lamps using 'In "Gaudoin artificial carbon,' 0.0016 meter in "diameter, and 0.018 meter long in their in-"candescent part. In the French Fontaine "the carbons in question are referred to as "'Charbons artificiels Gaudoin.'

"221 x-Q. Would your answers to cross- 7554
"questions 216 and 217 have been different if "the proportions of the carbon pencil referred "to in those questions had been 1.6 millime-"ters in diameter and 18 millimeters in length, "as stated in your last answer, instead of the "different length stated in question 216?

"A. They would not. * * * *

"224 x-Q. You have stated in answer to "question 79, that the term 'electric lighting' 7555
"was used at the date of the original Gau-"doin patent 'only as referring to arc lighting;' "did you intend to make any distinction be-"tween the use of that expression on "July 12, 1876, the date of the original "Gaudoin patent and April 7th, 1877, the "date of the first certificate of addition to "the Gaudoin patent?

"A. I did not have any such distinction in "mind in answering that question. What I 7556
"meant by my statement regarding electric "lighting was that the term 'electric light-"ing' was understood to mean arc lighting, "and that such was the sense in which that "expression would be taken. I did not in-"tend to state that no other kind of electric "lighting had been suggested at that time, "but that, if lighting by incandescence was

7557 "meant, it would be distinctly stated. Still "further, the expression 'pencils for use in "electric lighting' would certainly have been "understood as referring to arc lighting.

"225 x-Q. In view of the use of the small-"sized Gaudoin pencils in incandescent "lamps as stated by Fontaine, and in view of "your own recollection of having seen a state-"ment that such pencils were used in arc-
7558 "incandescent or semi-incandescent lamps, "do you wish to make any modification of "your answer to question 7, with respect to "the classification of the Gaudoin patent "and certificates of addition as being one of "the exhibits which relate 'only to arc-light-"ing and to the preparation of carbons for "this purpose?'

"A. I do not." * * * *

7559 "233 x-Q. Where in the patent in suit do "you find any description of the particular "form meant by the expression 'arch-"shaped?'

"A. There are pictures of the arch-shaped "form in the drawings, and the specification "says: 'The accompanying drawings show "'all our improvements embodied in an ap-"'paratus or lamp, * * * being the "'form in which we have practically used it,' "and a specific reference follows. The pat-
7560 "entees also say in the specification: 'We "'have also used conductors of varying con-"'tours, that is, with rectangular bends in-"'stead of curvilinear ones, but we prefer "'the arch-shape.' Also in Claim 1, the "conductor is referred to as having 'an arch "or horseshoe shape,' and in Claim 4 it is

7561 "spoken of as 'having the form of an arch or "loop.'

"234 x-Q. Then, aside from the illustration "by the drawings, there is no description of "what is meant by 'arch-shape?'

"A. I think there is; the arch-shaped "conductor is described by implication in "the specification as a conductor with curvi-"linear bends. It is also described in Claim "1 as having a 'horseshoe shape.' It is also 7562 "described in Claim 4 as having the form of "a 'loop.'

"235 x-Q. Where in the patent is there "any description or illustration of the horse-"shoe shape and the loop shape?

"A. I do not find any specific description "or illustration of the horseshoe or loop as "distinct from arch-shaped carbons in gene-"ral. Nor do I see that the meaning of these "terms would be made any plainer by further 7563 "description or illustration."

"236 x-Q. Are you aware of the fact that "arches are common with angular instead of "curvilinear bends, and that one form of "arch is similar to an inverted V?

"A. I do not understand what is meant by "an angular bend, and have not in mind the "kind of arch meant by this expression. The "inverted V construction referred to is not "what is ordinarily understood by the term 7564 "'arch-shaped,' though I think that I re-"member having seen pictures of such a "structure in architectural books as one "which was used considerably before the "Norman conquest in England, and I believe "that it was spoken of as a V-shaped arch, or "something of that kind. Certainly the term

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"'arch' is applied to such a construction by
" an extension of its original meaning.
" 237 x-Q. Would the ordinary Gothic arch
" be within what is ordinarily understood by
" the term 'arch-shaped?'
" A. This construction is undoubtedly arch-
" shaped. It is a pointed arch.
" 238 x-Q. Have you ever heard that a
7566 " helix, or coil, is known as an arch ?
" A. It is not customary to designate it
" thus, and it is not a term which one would
" naturally apply to it, since the curve makes
" a complete turn of at least 360 degrees, in-
" stead of being limited to a less number of
" degrees. But we call the roof of a long
" tunnel 'arch-shaped,' and we call the tun-
" nel itself 'arch-shaped,' even though its
" section extends over 180 degrees, and as is
7567 " often the case, has the shape of a horse-
" shoe. Or, looking at the matter from a
" geometrical point of view, if we have an arc
" of 180 degrees, the curve is unquestionably
" arch-shaped. If we extend this curve, until
" it is, say 270 degrees, it is still unquestion-
" ably arch-shaped, and arches of such charac-
" ter are used in architecture. If we con-
" tinue the curve through 360 degrees, I do
" not see that it ceases to be arch-shaped.
" But with either the helix or the spiral coil
7568 " the line is prolonged, so that instead of be-
" ing 360 degrees, it is twice or thrice, or any
" number of times 360 degrees. And it seems
" to me that we must still consider it as arch-
" shaped; and, using the term in a tech-
" nical sense, it might be spoken of as an arch
" certainly without any greater extension of its
" meaning than when we apply the term 'arch'
" to an inverted V.

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" 239 x-Q. Do you thing the term 'arch' is
" properly applicable to a form like the capi-
" tal letter M with the angles rounded ?
" A. Such a figure, it seems to me, is prop-
" erly included within the term 'arch-shaped,'
" and under certain circumstances might very
" properly be spoken of as an 'arch.' It is
" not, of course, for obvious reasons, a form
" used in architecture.
" 240 x-Q. Can you conceive of any form 7570
" having the angles rounded that would not, in
" your opinion, be properly described as arch-
" shaped ?
" A. I do not think of any such form which
" might not without impropriety be thus de-
" scribed, though there are various such
" shapes which are not ordinarily designated
" as arches. Of course, this answer is not to
" be taken as having reference to the Sawyer
" and Man patent in suit, or to the shape of 7571
" the carbon set forth in that patent." * * *
" 251 x-Q. What are the forms of incandes-
" cent lamps in which a straight carbon was
" employed, that you refer to in answer 14 as
" having seen ?
" A. Some of the earlier Bernstein lamps
" were those which I had in mind.
" 252 x-Q. Were they lamps having tenuous,
" flexible carbons, like that of the exhibit De-
" fendant's Lamp put in evidence by the com- 7572
" plainant?
" A. The lamp was for series lighting, and
" had a tubular carbon, in some respects like
" that shown in Complainant's exhibit Bern-
" stein lamp, except that the carbon was
" straight, and, as nearly as I recollect, larger
" in diameter.

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"253 x-Q. It was not a carbon of such tenuity as to have the high degree of flexibility that is possessed by the carbon in Complainant's exhibit, Defendant's Lamp?

"A. It was a stout and comparatively short carbon, and not tenuous like the carbon in Defendant's lamp, and undoubtedly much less flexible.

"254 x-Q. Would not the filament of
7574 "Complainant's Exhibit, Defendant's lamp readily bend and alter its shape as it expanded under increased temperature, even if made straight?

"A. I have never seen such a lamp with the straight filament, and do not feel at all certain as to what extent it could do this. Of course a tenuous filament would yield far more readily than a stiff one.

"255 x-Q. Have you any doubt that a fila-
7575 "ment of the extreme tenuity used in Complainant's Exhibit, Defendant's lamp, would readily bend laterally without breaking under changes of temperature, even if in a straight form?

"A. A filament as long as the one referred to would be, if straight, would undoubtedly bend with considerable readiness.

"256 x-Q. The arch or loop form has as one advantage, has it not, that of permit-
7576 "ting of an increased length of the conductor?

"A. Of course with an arch form the length of conductor which can be contained within a globe of given size will be greater than if the conductor was straight.

"257 x-Q. This is also an advantage of a V-shaped conductor, is it not?

"A. It is.

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"258 x-Q. Could a straight carbon of the total length of that employed in Complainant's Exhibit Defendant's Lamp, be placed within the globe of that lamp?

"A. It could not.

"259 x-Q. In answer to interrogatory 23, you have stated that the Bernstein lamp employs a filament of woven silk. Do you consider silk a vegetable in fibrous mater-
"ial? 7578

"A. It is a fibrous material but not a vegetable in its nature.

"260 x-Q. Is it not a fact that the hydro-carbon treatment which you have referred to as described in the Sawyer-Man patent 211,262, may be carried to such an extent that the deposited carbon itself may be stripped from the core and used as the conductor?

"A. I do not doubt that the carbon may 7579
"be deposited to such a thickness that it will have a sufficient body to form itself a conductor for an incandescent lamp. In saying this I do not of course express an opinion as to the practical value of a filament thus made.

"261 x-Q. What is the character of the carbon obtained by the hydro-carbon treatment?

"A. I have never seen any separated from 7580
"the backing on which it is deposited. Apparently, however, it is firm and even in its texture, giving a lustre to the filament on which it is deposited.

"262 x-Q. Is it dense?

"A. It is if it is deposited with sufficient thickness.

7581 "263 x-Q. Does the deposited carbon of "itself have a high or a low specific resis- "tance?

"A. I have never seen any measurement "relating to this. I should suppose that if "it were deposited in a thick layer such as "we have been speaking of, its specific resis- "tance would be lower than that of ordinary "fibrous carbon.

7582 "264 x-Q. Should you think it more or less "hard and dense than gas-retort carbon?

"A. I have never compared the two and "cannot say.

"265 x-Q. Is the deposited carbon—*per se*, "vegetable or fibrous or textile?

"A. It is neither.

"266 x-Q. Would an incandescent conduc- "tor made from the deposited carbon have "the properties which you consider requisite

7583 "for the conductor of an incandescent lamp?

"A. I have no experimental knowledge as "to the action of such a conductor.

"267 x-Q. Does the fact that you have no "experimental knowledge on this matter de- "ter you from expressing an opinion upon "it?

"A. I always dislike to speculate unless I "feel certain of my premises.

"268 x-Q. What experimental knowledge

7584 "have you with regard to the use of gas-re- "tort carbon for incandescent lighting?

"A. Little, so far as my own individual ex- "periments are concerned, but a good deal as "shown by the experiments of others.

"269 x-Q. What experiments of others do "you refer to?

"A. I had in mind the descriptions which

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"are given in various patents and publica- "tions, such, for example, as the various ex- "hibits in the present suit.

"270 x-Q. Have you any actual experi- "mental knowledge yourself as to the use of "gas carbon for incandescent electric light- "ing?

"A. I do not recollect that I have ever "tried to render gas carbon proper, incandes- "cent by the passage of an electric current. 7586

"271 x-Q. Have you any experimental "knowledge as to the action of such wood "carbon as is described in the Gandoin "French patent when employed for incandes- "cent lighting?

"A. I was not aware that these carbons "had been used for incandescent lighting, "and, if such is the case, I have no knowl- "edge of the fact.

"272 x-Q. You, then, have no experiment- 7587 "al knowledge as to the action of such a con- "ductor when employed for the conductor of "an incandescent lamp?

"A. If you ask me whether I have ever "tried, or seen tried, the Gandoin carbons for "this purpose, my answer is that I have not. "What I have said in my direct examination "with regard to these carbons has been de- "rived from the statements relating to them "in the various publications in evidence, and 7588 "from what seemed to me the immediate "consequence of such statements.

"273 x-Q. But, as I understand you, not "from actual experimental knowledge?

"A. That is the case.

"274 x-Q. What is the difference between "the character of the carbon, as a carbon, "deposited by the hydro-carbon treatment,

7589 "and the character of the carbon which Gau-
"doin adds to his wood carbon by impreg-
"nating the wooden objects before carboni-
"zation with the materials he mentions?
"A. The expression in the original Gau-
"doin certificate of addition for April 7,
"is 'carbone d'hydrogène.' This is a techni-
"cal chemical term of whose meaning I am
"not positive, but which I suppose is a com-
7590 "pound of carbon and hydrogen, of which
"the various substances mentioned are exam-
"ples. The nature of the deposited carbon
"will undoubtedly differ to a greater or less
"extent with the substance from which it is
"deposited, with the rapidity at which depo-
"sition takes place, with the temperature at
"which deposition takes place, and with the
"freedom of immediate complete decomposi-
"tion, and with the nature of the products of
7591 "decomposition. With such a large variety
"of influencing circumstances, you will read-
"ily appreciate the difficulty of giving a
"brief and positive answer to your question.
"I should expect, however, that there would
"be very decided differences between the re-
"sults of the hydro-carbon treatment and
"those of Gaudoin's process, not only in the
"structure of the conductor as a whole, but
"also in the peculiar qualities of the depos-
7592 "ited carbon. Certainly the carbon that is
"obtained by the decomposition of sugar is
"quite different from that which is obtained
"by deposition from hydro-carbon vapor
"upon the filament of an incandescent lamp.
"275 x-Q. It is true, is it not, that in each
"case, that is in the case of the hydro-carbon
"process described in Sawyer-Man patent No.

"211,262, and in the case of the process of 7593
"treatment of the wood carbon described in
"Gaudoin's French patent, the carbon depos-
"ited is one obtained by the decomposition
"by heat of a hydro-carbon?
"A. Sawyer and Man, in their specification,
"speak of using a hydro-carbon liquid, which,
"properly speaking, is a liquid containing
"only hydrogen and carbon. I am not cer-
"tain, however, that all of the substances 7594
"which they mention are free from oxygen. In
"their claim they speak of the use of a car-
"bon liquid, which I suppose would not ex-
"clude a liquid of which oxygen was a con-
"stituent part, provided that this was practi-
"cally operative. I should suppose, however,
"that the presence of oxygen in the liquid
"used would be objectionable. Gaudoin, on
"the other hand, in his patent, though refer-
"ring to hydro-carbons, also refers equally to 7595
"various other substances which contains oxy-
"gen as well. In my answer to cross-inter-
"rogatory 274, I omitted to notice that cer-
"tain of the substances mentioned by Gau-
"doin are not, properly speaking, hydro-car-
"bons, since they contain oxygen. I will
"assume, however, that your question limits
"itself to the case of the Gaudoin carbon,
"when a hydro-carbon is used. In that case
"it is true that with the Gaudoin carbon, as 7596
"with the carbon treated by Sawyer and
"Man's process, the deposited carbon is ob-
"tained by the decomposition of a hydro-
"carbon by heat. It does not, of course,
"follow from this fact that the properties of
"the deposited carbon in the two cases are
"identical.

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"276 x-Q. And in each case the deposited
"carbon is neither vegetable, fibrous nor tex-
"tile?

"A. It is certainly neither fibrous nor
"textile, nor could it even be what is under-
"stood by vegetable carbon. Of course, if a
"hydro-carbon of vegetable origin exists and
"were used, the deposited carbon would, in
"one sense, have a vegetable origin, and in
7598 "this sense one might possibly apply to it
"the term vegetable carbon. I do not think,
"however, that there would be any justifica-
"tion for this use of language.

"277 x-Q. Would the Gaudoin deposited
"carbon be more hard, dense or compact than
"that deposited by the Sawyer-Man process?

"A. I should think not. I should suppose
"it would be less homogeneous and compara-
"tively uneven in structure.

7599 "278 x-Q. Would it have a higher or
"lower specific resistance?

"A. I know of no data which would en-
"able one to be certain as to this matter. I
"should think it would depend very much
"upon the rapidity with which the carbon
"was deposited in the Sawyer-Man process,
"and upon the precise mode in which car-
"bonization took place with the Gaudoin
"carbon. I suppose that it would be easy to
7600 "give to the deposited carbon by the Sawyer
"and Man process a specific resistance either
"lower or higher than that obtained with the
"Gaudoin process. In discussing this mat-
"ter of specific resistance, however, it seems
"to me that there is a large element of ambi-
"guity which enters your questions, and
"which necessarily, therefore, enters my re-

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"plies thereto. The specific resistance of a
"substance is the resistance of a cube of that
"substance having unit surface and a thick-
"ness unity. Now, in the Gaudoin carbon I
"do not see how one can so isolate the de-
"posited carbon from the carbon upon which
"it is deposited as to determine its specific
"resistance.

"279 x-Q. Is there any radical difference
"in the specific resistance of the carbon de-
"posited in each of the two cases assumed in 7602
"the last few questions?

"Before answering this question, wit-
"ness says:

"I should like to say with regard to my an-
"swer to cross question 275, that since the last
"session I have consulted with several chem-
"ists as to the term 'carbon d'hydrogéne.' I
"am informed that this is not an expression 7603
"which would be used by one conversant with
"chemistry, but it undoubtedly means a
"hydro-carbon as I had supposed. I find al-
"so in relation to the substances mentioned
"by Sawyer and Man in their hydro-carbon
"patent under consideration, that turpentine
"is a true hydro-carbon, but that bees-wax
"contains oxygen.

"Witness continues in answer to ques- 7604
"tion 279:

"A. I cannot say whether there is or is
"not; that is, if by specific resistance you
"mean the specific resistance of a very small
"particle of the carbon. If by specific re-

7605 "sistance you mean the resistance of the sub-
"stance as it actually lies within and upon
"the treated carbon, I should think that there
"would be a difference, and not merely a dif-
"ference between the Sawyer and Man de-
"posited carbon and the deposited carbon in
"the Gaudoin process, but also a difference
"with the Gaudoin carbon according to the
"substances used and the precise prepara-
7606 "tion. This is what would naturally be ex-
"pected from the great difference in the two
"processes whereby what we have called
"'deposited carbon' is obtained.
"280 x-Q. Then in each case, that is the
"Gaudoin French patent and the Sawyer and
"Man patent No. 211,262, hydro-carbons,
"properly speaking, are mentioned as well as
"hydro-carbon compounds containing oxy-
"gen?
7607 "A. Taken literally, this is true, but I
"think there is quite a distinct difference be-
"tween them. Sawyer and Man propose dis-
"tinctly to make use of a hydro-carbon, and
"simply mention the substance bees-wax
"which contains oxygen. Gaudoin, on the
"other hand, distinctly proposes to use any
"substance containing carbon, whether it is
"really a hydro-carbon or not, and merely
"enumerates 'any hydro-carbon' among a
7608 "large number of substances. That is, there
"is nothing to indicate that Gaudoin consid-
"ered a hydro-carbon as in any way prefera-
"ble to any one of the other substances which
"he mentions.
"281 x-Q. Aside from what you consider
"the order of importance in which the two
"classes of materials are named in the two

"patents, it is a fact, is it not, that they both 7609
"mention hydro-carbon, properly speaking
"and hydro-carbon which contains oxygen?
"A. That is the case.
"282 x-Q. In your answer to question 33
"you state:

> "'It seems to me that the use
> "'of the glass plate or stopper is entirely
> "'novel with Messrs. Sawyer and Man.' 7610

"In the assumption upon which this state-
"ment is based do you omit the general
"knowledge as to the use of such a plate or
"stopper in pneumatic apparatus?
"A. I was perfectly familiar with the use
"of such a device in pneumatic apparatus. I
"did not consider it as material in its bearing
"upon the use of such a plate or stopper in
"an incandescent lamp.
"283 x-Q. In answer to question 34, you 7611
"state:

> "'It is quite true that any lamp poss-
> "'essing such low resistance' (as that
> "'of the patent in suit) 'would not be
> "'suited for use over considerable dis-
> "'tricts in a parallel system of illumina-
> "'tion; but on the other hand it is in
> "'this respect exactly the kind of lamp
> "'that is wanted for use in a series sys- 7612
> "'tem, and in fact lamps of low resist-
> "'ance and adapted to run in series are
> "'now customarily made and employed.'

"How long have such lamps been custom-
"arily made and employed?
"A. I do not recall when I first knew of
"series incandescent lamps being used com-

7613 " mercially and to any extent, but it is cer-
" tainly a good many years. I think that
" such lamps have been constructed from the
" very beginning of the art of incandescent
" lighting. There are, of course, obvious
" reasons why in the earliest days of incandes-
" cent lighting general attention was turned
" from the use of such incandescent lamps
" in series to the use of incandescent lamps of
7614 " higher resist ance and in parallel.

" 284 x-Q. Is it not a fact that incandescent
" lamps of low resistance run in series have
" only been customarily made and employed
" within the last three or four years?

" A. I am confident that I am correct in
" my recollection that incandescent lamps
" have been run in series for a much longer
" time than you mention. The resistances of
" those lamps were greater or less according
" to the circumstances under which they were
7615 " to be operation.

" 285 x-Q. Were they so 'customarily made
" and employed' before January 9, 1880?

" A. Not so far as I know. The conditions
" of electric lighting at that time do not seem
" to have been such as to call for them. The
" date that you mention was a very early one
" in the history of the art of commercial elec-
" tric lighting.

7616 " 286 x-Q. At that date it is a fact, is it
" not, the art of commercial incandescent
" electric lighting had developed only in the
" direction of high resistance lamps adapted
" to be run in parallel?

" A. The use of incandescent lamps in par-
" allel was naturally the first to develop, and
" at the date you mention, so far as I recol-

" lect, the parallel system of distribution was 7617
" the one ordinarily employed. The lamps
" used had various resistances, running per-
" haps from twenty ohms upwards. I think,
" however, that even at the early date you
" mention, lamps of low resistance were made
" and used, although this may possibly not
" have been the case until a year or two later.
" I should wish to refresh my memory by con-
" temporaneous data before being positive. *
" * * * 7618

" 288 x-Q. If no better styles of incandes-
" cent lamp existed, how poor a lamp would,
" in your opinion, have a distinct commercial
" value?

" A. I do not know of any scale of excel-
" lence whereby I could rank the different in-
" candescent lamps of history or imagination,
" or even if I had such a scale, where its zero
" point would lie, and for this reason I am
" unable to give a satisfactory answer to the 7619
" question.

" 289 x-Q. Do you think an incandescent
" lamp having a life of one hour would have a
" distinct commercial value, if no better style
" of incandescent lamp existed?

" A. There would not be a large demand for
" such lamps commercially, but it is possible
" that such a lamp might have its use in spe-
" cial cases Of course, such a lamp could
" not compete for general purposes with 7620
" other illuminants.

" 290 x-Q. But for some special purposes it
" might have a distinct commercial value, as
" I understand you?

" A. It is quite possible that it might. *
" * * *

7621 "298 x-Q. In answer to question 36 you "have stated in substance that there are advantages in using the arch-shape with carbon "which are not possessed by the use of that "form with metal conductors. Is it your "opinion, that those advantages are present "with carbon generally, or only with some "special character of carbon?

7622 "A. I should think that there would be an "advantage in using the arch-shaped conductor with any kind of carbon, since this "form allows the material to expand or contract without producing the excessive strain "which would occur if it were straight. It "is very possible, however, that with a brittle "carbon, such as gas carbon, even the use of "the horseshoe form might not be sufficient "to preserve it from rupture.

7623 "299 x-Q. Then, as I understand you, the "arch form in your opinion is even more "necessary with a conductor of brittle carbon, such as gas retort carbon, than with a "conductor of fibrous carbon?

"A. I had not intended to be understood "thus, and do not feel at all ready to make a "broad general statement of this kind.

7624 "300 x-Q. The advantages of the arch "shape would at least be equally important "with the gas or hard carbon conductor?

"A. It would seem so at first sight, assuming that the gas carbon is more brittle in all "cases than the fibrous carbon. I do not "feel at all positive, however, that the advantage of the shape with any and every "kind of fibrous carbon is necessarily greate

"than with gas carbon, because there are 7625 "various circumstances that come into play "regarding which I have no data in mind "which settle the matter beyond question.

* * * * *

"310 x-Q. Do you agree with the following "statements made by Prof. Edwin J. Houston, "who testified as an expert for complainant "in the suit brought by the same complainant 7626 "upon the same patent as involved in this "controversy against the Edison Electric "Light Co. and Thomas A. Edison, defendants, and now pending in the Southern District of New York?

Answer to cross Q. 69:

"'I think that in the manufacture of "'incandescent lamps the general custom "'in the art at the present time is to "'obtain the joint by the fusion of the 7627 "'glass, and not by the use of a cement.'

"And the last sentence of answer to cross "Q. 73,

"'as far as I am aware the incandescent "'lamps in general use are in accordance "'with the method in which the joints "'are fused together and not cemented.'

"Objected to as immaterial.

7628

"A. I do.

"311 x-Q. Do you agree with the following "opinion expressed by Prof. Houston in the "same case in answer to cross-question 123 "in comparing the Edison lamp with that of "the Sawyer-Man patent 205,144?

"'Or to summarize, I acknowledge "'that the following differences do exist

7629
"'in the two lamps in question, and I
"'have endeavored to point out to coun-
"'sel in previous answers that I am
"'aware of the existence of such facts,
"'namely: that we have in the case of
"'the Edison lamp as contrasted with
"'that of the lamp shown in Fig. 1 of
"'205,144 a high vacuum, as contrasted
"'with a low vacuum of an inert gas;
7630 "'that we have in the one a high resist-
"'ance as against a low resistance in the
"'other; that we have a lamp chamber
"'made of two separate pieces of glass
"'subsequently fused together, as against
"'a lamp chamber made of two pieces of
"'glass subsequently fitted together;
"'that we have in the case of 205,144,
"'which was presumably a lamp of high
"'candle power, more heat generated
7631 "'than in the case of the Edison lamp
"'exhibit; and that in 205,144 means
"'are provided to prevent this heat from
"'injuring the atmosphere left in the
"'lamp chamber.'

"Same objection.

"A. The differences between the two lamps
"referred to by Prof. Houston undoubtedly
"exist.

7632 * * * * *

"314 x-Q. You have stated, in substance,
"in answer to question 44, that the process
"of making a practical conductor for an in-
"candescent lamp was well known prior to
"the application for the patent in suit. How
"widely was such process known?

7633
"A. I do not think that your question fair-
"ly represents my answer to interrogatory 44.
"In that answer I endeavored to show what
"would have been done in the light of exist-
"ing knowledge by one wishing to follow out
"the directions of the Sawyer and Man pat-
"ent, and construct an incandescent lamp. I
"certainly did not state therein that 'the
"process of making a practical conductor for
"an incandescent lamp was well known prior 7634
"to the application for the patent in suit;'
"but I did endeavor to show, and I think
"with sucess, that the state of knowledge
"was such that with the directions given by
"Sawyer and Man, an incandescent lamp
"could be constructed by one skilled in the
"art, and without the exercise of invention.

"315 x-Q. In justification of your position,
"that no especial description as to the car-
"bonization was required in the patent in 7635
"suit, in order to enable one skilled in the art
"to produce a practical carbon conductor for
"incandescent lamps, you state, in answer 44
"that

"'the subject of carbonization had been
"'carefully studied, and the methods
"'whereby thorough, uniform and com-
"'plete carbonization could be secured
"'were perfectly well known to those 7636
"'skilled in the art'—

"to what art did you refer?

"A. The art of carbonizing woods and
"other fibres. Illustrations of the state of
"this art are found in the papers of Violette
"and Sidot which are exhibits in the present
"suit.

"316 x-Q. Was the subject also well understood by scientific men and electricians, such as yourself?

"A. It was well understood by scientific men. I had not considered the subject of carbonization myself at the date of the application for the patent, and therefore was not particularly well informed regarding it.
7638 "I do not think, however, that I should have found difficulty in putting the invention under consideration into practice.

"317 x-Q. That is, you think that you were sufficiently well acquainted with the art as to carbonization to enable you to do it, or at least to direct workmen how to do it?

"A. Of course if I had proposed to make such a lamp which involved the carbonization
7639 "tion of paper or other similar material, I should have made inquiry of those possessing a technical knowledge of carbonization as to the best process to follow, just as in following out the directions of any patent to-day, I should inquire as to the technical details of any portion of the process outside of my immediate specialty. If, for example, I wished to make an Edison lamp today, following out the directions in any one
7640 "of Mr. Edison's patents, I should make inquiry as to the best method of connecting the filament to the heating wires, the best form of air pump to use in practice, etc.

"318 x-Q. Outside of details of manipulation, did you yourself at the date of the application for the patent in suit, understand the perfection to which the art of carbonization had been carried?

"A. It is difficult for me to say specifically 7641
"and in detail what I personally did or did not know regarding carbonization at the date mentioned in the question, since I had then had no occasion to consider any question involving the practice of this art. I am certain, however, that I was well aware that the art of carbonization had been carried in certain directions to a state of great
"perfection. 7642

"319 x-Q. Were you better acquainted with the matter in 1881?

"A. I do not doubt that I was.

"320 x-Q. Are you better acquainted with it now than you were in 1881?

"A. I am.

"321 x-Q. Were you not at one time retained as an expert by the Edison Electric Light Co.?

"A. I was; I accepted a retainer from them 7643
"for a single year.

"322 x-Q. What time did the retainer cover?

"A. I don't remember the date, but it must have been about 1881.

"323 x-Q. During the time of your employment by that company did you make an examination of patents and publications relating to electric lighting, and give an opinion to the company upon the matters
"to which the examination was directed? 7644

"A. I did make an examination of certain patents and publications to which they directed my attention. I do not think that I made any extended research outside of these, although I doubtless made reference to such books as I was especially familiar with relating to the subject in question.

7645 "324 x-Q. Are the two letters I hand you "dated June 23, 1881, and June 24, 1881, "and addressed to F. H. Betts, Esq., the re- "port which you made as the result of the "examination referred to in your last answer?

"A. There is no doubt that such is the "case. I recollect them perfectly.

"325 x-Q. What relation did Mr. Betts "hold to the Edison Electric Light Co., at "that time, if you know?

7646 "A. I understood that Mr. Betts was of "counsel for the Edison Company.

"The letters referred to are offered in "evidence by counsel for defendant, and "the same are marked 'Defendant's Ex- "hibit Prof. Cross' report of 1881, April "20, 1889, (No. 1 and No. 2.)

"Said exhibits objected to as immater- "ial" * * *

7647 "332 R-d-Q. Is there any substance enume- "rated in the Gandoin patent or the addi- "tions thereto which, if treated by the pro- "cess therein described, would result in the "same thing, in structure and properties, as "the fibrous or textile conductor of the patent "in suit, if such conductor in the course of "its manufacture was treated by the Sawyer "and Man hydro-carbon process?

7648 "A. There is not. The endeavor of that "patent is to produce a hard carbon, equally "hard throughout. The aim of the hydro- "carbon treatment as applied to a fibrous "conductor is to equalize its resistance and "to heal imperfections, the carbon being de- "posited precisely where it is needed and not "elsewhere, so that its deposition is greater "at those points where it is needed most. No

7649 "such operation is intended or is possible "with the Gaudoin carbons, and in that pro- "cess there will be secured either an approx- "imate evenness of deposition of the carbon "or more likely an unevenness which would "be quite as likely to give an excessive de- "position where it would do harm in an in- "candescent lamp as where it would do "good.

"333 R-d Q. Please state generally, so far as "you remember, what patents or publications 7650 "you examined as the basis of your opinion "to the Edison Co., which has just been put "in evidence, and particularly state whether "you had or had not then examined the Lane- "Fox patents in evidence in this case.

"A. I must answer this question wholly from "memory, as my various memoranda are in "Boston. I consulted chiefly, if not entirely, "certain patents and publications of which a "list was sent me by the Edison Company. I 7651 "have no recollection of reading the Lane- "Fox patents till within a very few weeks."

x-Q. 71 continued by counsel for Complainant.

Do the foregoing questions and answers which I have just read form a part of the deposition given by you in the McKeesport case as stated in answer to x-Q's. 68 and 70?

A. They do. 7652

72 x-Q. In the McKeesport deposition you recollected having made a report to the Edison Electric Light Company contained in two letters dated June 23, 1881, and June 24, 1881, addressed to F. H. Betts. Are the letters which I now hand you the original letters written by you as stated in your deposition in the McKeesport case?

7653

A. They are.

> Counsel for complainant offers in evidence the two letters shown the witness, and the same are marked respectively "Complainant's Exhibit Cross-Betts letter of June 23, 1881," and "Complainant's Exhibit Cross-Betts letter of June 24, 1881."

73 x-Q. In your deposition in the McKeesport case
7654 in answer to R-d Q. 333, you state from memory that the examination made by you before writing these letters was based chiefly, if not entirely, on certain patents and publications of which a list was sent you by the Edison Co. Have you preserved the letter containing that list, or a copy of it?

A. I have done so and will bring it with me to-morrow morning.

7655 74 x-Q. Did you testify as a witness for the defendant in any of the suits brought upon the patent to Gaulard and Gibbs on the Converter System of Electric Lighting, No. 351,589, granted October 26, 1886?

A. I did in the case of the Westinghouse Co. against the United States Co., pending at the time in the Southern District of New York.

75 x-Q. In the present case, you have testified in answer 51, that two of the defendant's lamps, the 60 and 70 volt lamps, are capable of extensive use for the
7656 purpose of general illumination, when used in connection with the converter or transformer system. Do you refer to the system described in the Gaulard and Gibbs patent No. 351,589?

A. That is one form of the converter system, though not one which is practically used at present.

76 x-Q. The Gaulard and Gibbs patent, however, describes the fundamental principle embodied in the system at present used, does it not?

A. It describes a converter through whose primary

7657

s passed an alternating current, and in whose secondary are placed incandescent lamps. This broad feature is used in the present converter system.

77 x-Q. Does it not also describe a converter which reduces the tension of the current, and is that not also used in the present converter system?

A. That is the case.

78 x-Q. Did you not testify in the case referred to 7658
in answer to x-Q. 74, that the converter system described in this Gaulard and Gibbs patent, or all essential or material features of it, were known to the art at least as early as 1878?

A. I do not recall precisely the various statements which I made in that case. I did, however, bring forward certain facts which seemed to me to be in strong opposition to the views as to the Gaulard and Gibbs patent which were held by the complainant.

7659

79 x-Q. Did you not testify in that case that there was no novelty in the converter system as described in the Gaulard and Gibbs patent, and further, that there was no invention as distinguished from engineering skill required in the production of the system described in that patent?

A. I should prefer reviewing my deposition in that case before answering as general and vague a question as that which you ask. I do recollect distinctly showing in that deposition that what are called potential- 7660
lowering induction coils were known prior to the date of the Gaulard and Gibbs patent referred to, and I also believed that there was no substantial novelty in combining an alternating dynamo with such converters. I do not recall having indicated any belief that a converter system was recognized as a practicable one for operating incandescent lamps on a large scale prior to the date of that patent.

79a x-Q. In expressing the opinion contained in your answer 53 and in your other answers referred to therein,

that there was no invention, as distinguished from engineering skill, in the passage from the older lamps with their carbons of assumed comparatively large cross-section and low resistance, to the lamp of the patent in suit having a burner of smaller cross-section and higher resistance, and in expressing the opinion contained in your answer to Q. 63, that the problem under discussion by Preece and Schwendler called "subdivision of the electric light," was limited to the question of the practicability of subdividing the light and producing
7662 small lights with the same or approximately the same economy as the large arc lights, and did not include the broader question of the practicability of producing small lights by electricity—did you have in mind the general literature upon the subject of electric lighting published before the date of the patent in suit?

A. In my answer referred to I had in mind the state of the art as far as I was acquainted with it. I do not wish to be understood, however, as accepting your summary as expressing fully my views as to the papers of
7663 Preece and Schwendler.

79b x-Q. How extensive is your acquaintance with the published state of the art upon electric lighting, especially upon that portion of what has been called the subdivision of the electric light, prior to the patent in suit?

A. I have endeavored to keep myself informed as to the matters regarding which you inquire, and think I am conversant with at least the leading opinions which have been held regarding the subject to which you par-
7664 ticularly refer.

79c x-Q. Have you had at your command the leading technical journals in which these opinions are found?

A. I have had at hand the leading electrical journals and other publications in which I should expect to find whatever was written on the subject. The literature upon the particular subject under consideration is however not large.

7665

79d x-Q. How extensive an examination of the literature relating to electric lighting did you make before testifying in this case, or while testifying?

A. I was already familiar with the leading papers which have been written on the subject. I looked over a great many of these, and either came across or had pointed out to me some which I do not recollect having met with before.

80 x-Q. Were you also familiar with the opinions
expressed by the various experts called to testify be- 7666
fore the Parliamentary Committee early in 1879?

A. I have been familiar with the publication ever since it was issued.

81 x-Q. In expressing the opinions in your direct examination which are referred to in my question 76, did you bear in mind the statements made by these experts?

A. I was not forgetful of them.

Adjourned till 10:30 A. M., Feb'y 28. 7667

New York, February 28th, 1890.

Met pursuant to adjournment.

Present, Counsel as before.

Cross-examination of Charles R. Cross, continued.

82 x-Q. Referring to your answer to 73 x-Q. will you produce the letter as therein stated and state what it is?

A. I have brought the letter with me this morning 7668
and produce it. It is a letter which was sent to me by Mr. Fredk. H. Betts, of counsel for the Edison Co., the letter bearing the date of May 27, 1881.

The letter referred to is offered in evidence by complainant's counsel, and the same is marked Complainant's Exhibit "Betts-Cross Letter of May, 27, 1881."

7669 It is stipulated that copies of the several letters written by or to the witness which have already been or may be offered in evidence shall be made by the Examiner, and substituted in the record in place of the original letters.

83 x-Q. Have you the memorandum Mr. Wilbur referred to in Mr. Betts' letter of May 27, 1881? If so, will you kindly produce it?

7670 A. I have brought the memorandum with me and hereby produce it.

Counsel for complainant offers the memorandum in evidence and the same is marked Complainant's Exhibit "Wilbur-Cross Memorandum of May 25, 1881."

Stipulation as to copy to be made by Examiner and substituted in the record, continued as to this Exhibit

7671 84 x-Q. Is the letter which I now hand you the letter which, in your letter of June 23, 1881, you say you will write as soon as you hear from your chemists?

A. It is.

Counsel for complainant offers in evidence the letter referred to and the same is marked Complainant's Exhibit "Cross-Betts letter of June 27, 1881."

7672 85 x-Q. Do you recollect, in connection with the letters which have already been offered in evidence, receiving from S. B Eaton, at that time Vice-President of the Edison Electric Light Co., two letters dated May 17, 1881 and June 16, 1881, copies of which I now hand you?

A. I had forgotten those particular letters until you presented them to me, but I now recall them and their

contents. I did recollect, however, that a letter was sent, referring me to certain English patents which I examined and of which I kept a list; that list if I recollect rightly, is identical with the list contained in the letter of June 18, 1881, which you have just shown me. 7673

Complainant's counsel offers in evidence the two letters referred to, and the same are marked respectively Complainant's Exhibit "Eaton-Cross Letter of June 16, 1881" and Complainant's Exhibit "Eaton-Cross letter of May 17, 1881." 7674

86 x-Q. Do the letters which have been offered in evidence from Mr. Betts to you, from you to Mr. Betts, and from Major Eaton to you, and the memorandum from Mr. Wilbur, include all the material parts of the correspondence and papers explanatory of your report to the Edison Electric Light Company on the patent in suit?

A. They do so far as I am aware. I know of nothing else whatever, beyond a few notes which I made of the contents of some of the documents which I examined, and a few simple arithmetical calculations which I made at the time. 7675

87 x-Q. In expressing the views which you have given on your direct examination with regard to the engineering and non-patentable character of whatever novelties may be presented by the patent in suit, and with regard to the real character of the problem under discussion in 1878 and 1879, called the subdivision of the electric light, did you have in mind the experimental work of Fontaine upon this subject, as set out in his work on Electric Lighting, especially in Chapters XI and XII, and the conclusion he reaches in Chapter XI as follows: 7676

"From what precedes, it appears to result that King "and Lodyguine's system is much more favorable to

7677 "large foci than to the divisibility of the electric "light."

A. I did.

Complainant's counsel offers in evidence Chapters XI and XII of the book referred to, and the same is marked Complainant's Exhibit "Chapters XI and XII, 1st Edition of Fontaine, Higgs Translation."

Defendant's counsel objects to the preceding offer as being made out of time; inasmuch
7678 as said Fontaine's book constitutes no part of the present deposition, and if put in evidence at all by complainant, should be so offered when complainant is taking its own proofs.

88 x-Q. Is the King and Lodyguine system referred to by Fontaine arc lighting or incandescent lighting?

A. The lamps of King and Lodyguine were incandescent lamps.

89 x-Q. In expressing the opinion referred to in
7679 x-Q. 87, did you have in mind the article by Prof. Morton published in the *American Gas Light Journal*, which is already in evidence?

A. I had read the lecture referred to, though I do not recollect that I had it particularly in mind in giving my answers regarding which you inquire, but on examining it, I see nothing in it to modify in any way any of the opinions which I have expressed.

90 x-Q. Does not the article of Preece which you
7680 have referred to, terminate with a reference to Chapter XI of Fontaine's Electric Lighting; and what do you understand the reference to mean?

A. It does so terminate. He refers, I suppose, to the various experiments which Fontaine mentions, in which he experimented with certain forms of incandescent lamps.

91 x-Q. Does it not appear that in Mr. Preece's mind at least, the problems of multiplying and subdividing the light were one and the same problem?

A. I don't feel certain of that. It seems to me 7681
that Mr. Preece's paper is in certain respects quite confusing and that he did not fully realize what he had actually proved, as will appear clearly from a consideration of Mr. Schwendler's criticism of Mr. Preece's paper which criticism I have quoted in answer to Q. 60. Certainly Mr. Preece's demonstrations proved nothing in regard to multiplying the light.

92 x-Q. In expressing the opinions referred to in x-Q. 87, did you have in mind the lecture of Mr.
Preece, entitled "The Criteria of the Electric Light," 7682
published in the *Telegraphic Journal* for February 15, 1879, which I now hand you?

A. I do not recollect that I had that article particularly in mind, though I believe I had read it at some previous time. On examining the article, however, I see nothing in it which would lead me to modify the statements I have made, or the conclusions I have drawn in my direct examination. This lecture, like the article in the Philosophical Magazine, the conclusions
in which Mr. Preece evidently has in mind, shows that 7683
Mr. Preece evidently had not put the problem with which he was dealing as distinctly and clearly before his mind as he probably would have done, had it been a simple matter of telegraphy, which was then, as it is still, the branch of electricity to which he had given special attention, and regarding which his opinions are of especial value.

Complainant's counsel offers in evidence
the Philosophical Magazine paper of Preece 7684
which was referred to on the witness's direct examination as well as on his cross, and the same is marked "Complainant's Exhibit Preece *Philosophical Magazine* Publication of January, 1879." Complainant's counsel also offers in evidence the *Telegraphic Journal* publication referred to, and the same is

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marked "Complainant's Exhibit Preece *Telegraphic Journal* Publication of February 15, 1879."

93 x-Q. In expressing the opinions referred to in x-Q. 87, did you have in mind the discussion of the division of the electric light contained in Chap. 10 of the work entitled "The Electric Light in its Practical Application," by Paget-Higgs, published in London in
7686 1879—a copy of which I hand you?

A. I did not have this particular article in mind. I had, however, read it, though a good while ago. I have, however, examined it since your question was asked, and so far from finding anything in it which would lead me to modify the conclusions with regard to which you are questioning me, on the other hand, so far as it goes, it tends rather to confirm me in the views which I expressed in my direct examination.

7687 Complainant's counsel offers in evidence the chapter from Higgs book referred to, and the same is marked "Complainant's Exhibit Higgs Book of 1879."

Defendant's counsel objects to the introduction by complainant of the last exhibit, as well as the two exhibits marked "Preece *Philosophical Magazine* Publication of January, 1879," and "Preece *Telegraphic Journal* of February 15, 1879," for the reasons given after answer to x-Q. 87 in regard to the Ex-
7688 hibit chapters of Fontaine's Work."

It is stipulated that the same objection may apply to such other offers, of similar exhibits, as complainant's counsel may hereafter make.

94 x-Q. In expressing the opinions referred to in x-Q. 87, did you have in mind the letter of Sylvanus

P. Thompson, published in *Engineering* for October 25, 1878, under the headline title, "Divisibility of 7689
the Electric Light from a Dynamical Point of View." I call your attention particularly to the matter in the letter beginning with the sentence, "Now apply these matters to the problem of the subdivision of the electric light?" Also, did you have in mind the lecture by the same gentleman, published in *Engineering* for Dec. 20, 1878, and Dec. 27, 1878?" I call your attention particularly to the matter beginning with the 7690
sentence, "And now we must turn to the third of the the disadvantages of the electric light, its extreme and dazzling brilliancy, and consider some of the suggestions that have been made for reducing it to more manageable and endurable proportions."

A. I did not have these specific publications in mind when I gave my testimony in the direct examination. The statements made in these lectures, however, are in no way contradictory to the views which I have formed, and in no way lead me to modify these 7691
views.

Complainant's counsel offers in evidence the publications referred to, and the same are marked respectively, "Complainant's Exhibit Thompson's *Engineering* Letter of Oct. 25, 1878," and "Complainant's Exhibit Thompson's *Engineering* Lecture of Dec. 20–27, 1878."

95 x-Q. In expressing the opinions referred to in 7692
x-Q. 87, did you have in mind the communication from William Trant entitled "The Divisibility of the Electric Light," published in *Nature* for Nov. 21, 1871, which I now hand you?

A. I was quite unaware of the existence of this letter, but I find nothing in it to lead me in any way to modify my views as previously expressed. This would be the case even if it were written by one skilled in

7693 the art of electric lighting. It is evident, however, from his reference to certain physical laws, that the writer had a very imperfect knowledge of even simple principles in physics, so that his opinions upon the subject under consideration are really of no value whatever.

96 x-Q. In expressing the opinions referred to in x-Q. 87, did you have in mind the statement contained in the editorial article in the *Telegraphic Journal* for Oct.
7694 15, 1878, entitled "Gas v. Electric Lighting," which statement is as follows; "It is true that at present an "invention by which the electric current supplying the "electric lamps can be subdivided so as to feed a great "many light centres and thus at the same time moderate "while it distributes the light, is a desideratum neces- "sary to the complete success of electric lighting even "for general street purposes, let alone household uses. "But tried inventors are at work on the problem, and "any day may see its accomplishment."

7695 Objected to, in addition to the reasons heretofore indicated, on the ground of immateriality.

A. I did not have that editorial particularly in mind. I do not find in it, however, anything in contradiction to the views which I have expressed in my direct examination.

7696 97 x-Q. In expressing the opinions referred to in x-Q. 87, did you have in mind the testimony given before the Parliamentary Committee, between April 25, 1879 and June 13, 1879, and more especially the opinions expressed by the following witnesses in the questions and answers as follows, found in the pages of such evidence here given:

Prof. John Tyndall, Q. 78, p. 12; Q. 93, p. 13; Q. 105, p. 14.

Mr. C. W. Siemens, Q. 151 p. 20. 7697

Mr. Conrad W. Cooke, Q. 388, p. 47; Q. 425, p. 51.

Mr. William Henry Preece, Qs. 510, 511 and 512, p. 66.

Mr. John Hopkinson, Q. 624, p. 76.

Sir William Thomson, Q. 1779 and 1780, p. 180?

A. I did. 7698

Complainant's counsel offers in evidence the extracts from the evidence referred to, and the same is marked "Complainant's Exhibit Parliamentary Evidence, April-June, 1879."

98 x-Q. In expressing the opinions referred to in x-Q. 87, did you have in mind the following publications: The article entitled "Considerations sur l' Eclairage Public par les procédés Electriques" by Th. 7699
Du Moncel, published in *La Lumiere Electrique* in the first number of that journal, without date, but published prior to May 15, 1879; the article entitled "Quelques Réflexions a l'égard de la nouvelle lampe de M. Edison," by Du Moncel, published in *La Lumiere Electrique* for January, 1880; the article entitled "Les procédés Edison" also published in the first number of *La Lumiere Electrique* before referred to; the article published in *La Lumiere Electrique* for October 1, 1881, by Du Moncel, entitled "Les 7700
Lampes Electriques à l'Incandescence," also the article by the same writer in the same number of *La Lumiere Electrique*, entitled "Systeme de L'Eclairage Electrique de M. Edison;" also the editorial article published in *Nature* for February 12, 1880, and entitled "Edison and the Electric Light"?

A. I did not have these articles particularly in mind although I recollect having read most, if not all of,

7701 them. I have considered them carefully since you have called my attention to them, but I find nothing in them which in any way tends to alter the opinions which I expressed in my direct examination. On the other hand, so far as the matter which they contain is at all material to the question under consideration, they tend rather to confirm me in those conclusions.

Complainant's counsel offers in evidence the four articles by Du Moncel referred to
7702 and the same are marked "Complainant's Exhibit Du Moncel *La Lumiere Electrique* Articles" 1, 2, 3, 4 respectively, also the article in the first number of *La Lumiere Electrique* entitled Les Procédés Edison and the same is marked "Complainant's Exhibit *La Lumiere Electrique* Article 5;" also publication in *Nature* for February 12, 1880, and the same is marked "Complainant's Exhibit Nature publication of February 12, 1880."

7703

99 x-Q. In expressing the opinions referred to in x-Q. 87, did you have in mind the following statements made in *Engineering* and *The Engineer*: *Engineering* for February 21, 1879, p. 61 is as follows:

"Whether Mr. Edison's system for utiliz-
"ing electric current can only be satisfactorily
"demonstated by actual experiment and ex-
"perience, it will be severely handicapped
7704 "against all electric arc systems by the visi-
"ble drawback common to all incandescent
"systems, namely, that for each addition to
"the number of lights in circuit an enormous
"reduction is made in the intensity of the
"light produced. We, therefore, cannot but
"believe that we have not yet seen the system
"by which Mr. Edison states in his more re-
"cent letters to this country that he is able
"to place 678 electric lamps in one circuit."

The Engineer for January 10, 1879, in an editorial article on the Electric Light says as follows: 7705

"Electricians who were not commercially
"interested in any form of electric lamp or
"machine showed that this subdivision could
"only be effected by an enormous expense
"for light and material, owing to causes which
"we need not stop to explain. Again very
"thick conductors are essential to any suc-
"cess in subdividing the electric light, and 7706
"we shall be under the mark if we state
"that the cost of copper wire alone for con-
"ductors in London, assuming the power to
"be concentrated in a very few stations, and
"the light to be extensively subdivided,
"would amount to some £15,000,000 or £20,-
"000,000. If thin conductors are used, the loss
"of light is enormous; and this truth Mr.
"Edison has apparently only just discovered,
"for he admits that under his system it will 7707
"be impossible to obtain more than one-
"tenth of the light which could be had with
"a given power and moderate subdivision.
"* * * * Before the electric light can be
"subdivided with facility and economy, the
"operation of some new law must be discov-
"ered, and this we hold to be extremely im-
"probable."

Question objected to as immaterial

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A. I had the first distinctly in my mind in expressing my views referred to in the answer named. The extract from *The Engineer* referred to in your question I had not seen. A consideration of it, however, does not in any way lead me to modify the views which I have expressed.

100 x-Q. In expressing the opinions referred to in

7709 x-Q. 87, did you have in mind the statement made in the article entitled "The Edison Electric Light" published in *The Engineer* for February 14, 1879, as follows:

> "With all its defects for domestic purposes, "still Mr. Edison's lamp might perhaps be "used to much advantage for street lighting, "and in factories, or theatres; in fact in any "situation where it could be looked after by
> 7710 "a skilled attendant. If the current can be "successfully divided among dozens of such "lamps, then may gas-makers quake; but "nothing of the kind can be done?"

A. I did not have this article in mind, but I find nothing whatever in it to alter my conclusions. Apparently it relates only to Mr. Edison's platinum lamp in combination with his tuning-fork dynamo and some auxiliary devices.

7711 Complainant's counsel offers in evidence the extracts from *The Engineer* and *Engineering* referred to in the last two questions, and the same are marked Complainant's Exhibit "*Engineer* and *Engineering* Extracts."

Defendant's counsel objects upon the same grounds as before, and on the further ground that the said extracts without the context are misleading as to the purport of said articles.

7712 Complainant's counsel replies that the extracts are complete in themselves and not misleading and not modified by the context, and the articles themselves being in the possession of defendant's counsel, he can himself put in evidence such other portions as he sees fit.

Defendant's counsel states that the testimony of complainant's counsel above given is

objected to as incompetent and not in order at this stage of the case. 7713

Further hearing adjourned subject to agreement.

BOSTON, MASS., March 13, 1890.

Met pursuant to agreement; present counsel as before, and Cross-Examination by Mr. DYER, continued;

101 x-Q. In expressing the opinions referred to in 87 x-Q., did you have in mind the statements made in the preface of the first edition of Fontaine's book on 7714
Electric Lighting, from which the defendant has offered in evidence Chapter III, and the Complainant has offered in evidence Chapters XI and XII; also did you have in mind the statements contained in the preface of the second edition of Fontaine's book published in 1879; also did you have in mind the statements contained in Chapter XIII of the third edition of Fontaine's book published in 1888. Of this last book I refer to the opening statement of Chapter XIII under the head of "Industrial lamps" on page 396 and the 7715
opening statement on pages 404 and 405 under the head of "Swan Lamps?"

The books referred to in this question are handed to the witness and the particular portions indicated.

A. I did not have the documents referred to particularly in mind, though I believe that I had read the prefaces referred to of the first and second edition of 7716
Fontaine. I did not consider the portions quoted from the last edition of Fontaine 1888, which is very far from being a contemporaneous document. I find nothing in these various statements to modify the views which I expressed in my direct examination.

Complainant's counsel offers in evidence the publications referred to in the last question and answer as follows:

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1. Preface of the first edition of Fontaine's book, Chapters XI and XII of which were offered after 87 x-Q., and the same is marked "Complainant's Exhibit Preface first edition of Fontaine, Higgs translation."

2. A translation of the preface of the second edition of Fontaine's Electric Lighting, published in 1879, and the same is marked "Complainant's Exhibit Preface 2d edition of
7718 Fontaine."

3. A translation of the Extracts referred to, taken from Chapter XIII of the third edition of Fontaine's Electric Lighting published in 1888, and the same is marked "Complainant's Exhibit Extracts from 3d edition of Fontaine."

Cross-examination closed.

7719 *Re-direct examination by* S. A. Duncan, Esq.:

102 R-d Q. On cross-examination, complainant's counsel has made long quotations from your deposition in the McKeesport suit. What was the nature of the invention covered by the patent upon which that suit was brought?

A. The invention referred to was an incandescent lamp made wholly of glass and containing a burner made out of carbon from fibrous or textile material and of an arch shaped form. The issues of that case,
7720 as I understand them, were totally different from those of the present case.

103 R-d Q. How far does the patent involved in the present suit depend upon the use of a *fibrous or textile* material for the construction of the burner?

A. It in no way depends upon the use of such material, since the form of burner which it specifically

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describes is made of tar-putty which is not a fibrous or textile material.

104 R-d Q. Reference has been made on your cross-examination to a correspondence between yourself and Mr. Betts in the year 1881, in relation to the patent now in suit. What were the circumstances under which this correspondence took place, and how far did you regard the views set forth in your letter of June
23, 1881, as definitive and final? 7722

A. The circumstances under which the correspondence took place were the following. I received from Mr. Betts a copy of the patent in suit and also of the Edison patent relating to his platinum vacuum-lamp, together with some memoranda by Mr. Wilbur and samples of the Edison and Maxim lamps. I also examined a number of English patents to which my attention was called. I was desired by Mr. Betts to consider whether the Maxim lamp sent me was a lamp of
high resistance, and also whether the leading-in wires 7723
were of platinum and sealed into the glass, as set forth in one of the claims of the platinum-lamp patent. Mr. Betts also suggested a criterion by which to judge whether any particular lamp was or was not the lamp of high resistance set forth in the Edison patent in suit. I understood that what Mr. Betts desired was a general statement of my views upon the matters referred to in his letter, upon the assumption that the interpretation of the claims assumed by him was the
correct one. 7724

I assumed that what was desired was simply a preliminary report of my judgment in the matter, based upon such time as I could then give to it, the company being in a hurry for a statement of opinion in order that they might enter a suit against the U. S. Co. I supposed that my report would be speedily followed by further correspondence or more

7725 likely by personal conference with Mr. Betts, as is usual in such cases, and that at such time the whole subject of the interpretation of the patent and its relation to the state of the art would be discussed between us. For these reasons I confined myself strictly to a consideration of the specific topics referred to in Mr. Betts' letter and put my reply to a considerable extent in an interrogative and conditional form, that it might directly lead to further consideration as well as to indi-
7726 cate the uncertain state of my mind as to some of the matters which I was asked to consider.

Adjourned for lunch.

105 R-d Q. Did you at the time form a judgment as to whether the words "carbon of high resistance" of claim one of the patent in suit, related to the *specific* resistance of the carbon burner as contrasted with its *total or absolute* resistance, and, if not, why not?

A. I did not form any opinion whatever regarding this matter, but accepted the interpretation of this ex-
7727 pression which Mr. Betts had given to it. I did not understand that I was desired to consider the propriety of the interpretation of the expression quoted in the question, but gave Mr. Betts the conclusions which I had reached, accepting his premises as to the meaning of this expression of the patent without question.

106 R-d Q. When did you form the judgment that the words last above quoted from claim one of the
7728 patent relate to *specific* resistance, as you have more fully explained on your direct examination?

A. Not until a few months ago. I had no occasion to consider this patent minutely after my correspondence with Mr. Betts, until I had given attention to it in connection with the present suit. The interpretation of this claim to which you refer was first suggested to me by reading the testimony of complainant's witness

in this suit, Prof. Barker, who considered the high resist- 7729
ance referred to in the claim to be high *specific* resistance. This interpretation of the expression seemed to me a very reasonable one and removed certain difficulties which otherwise I should have strongly felt in understanding the complete meaning of the patent.

107 R-d Q. In your letter to Mr. Betts of June 23, 1881, speaking of the patent now in suit, you say: "Mr. Edison here describes for the first time (if I am 7730
right) a process by which a carbon filament can be made practically." How full an investigation did you at that time make as to the process of manufacturing carbons for electric lights, and do you now know of, any process of making carbons of earlier date than Edison's patent which would lead you to modify the opinion suggested in the words above quoted as to the probable or possible novelty of Edison's process.

A. I did not make any real investigation as to the methods of making carbons for incandescent lights, 7731
prior to the date of the Edison patent in suit, although I was acquainted with the description of the various methods of manufacturing carbons which were to be found in the books on electric lighting. I had an impression at the time, derived I presume from reading various newspaper articles, that Mr. Edison was the first one who had produced a fine carbon practicable for use in an incandescent lamp. I did not consider it necessary to investigate the subject at the time, and I worded my reply in such a manner as to indicate 7732
that my conclusion was not a final one, but rather based on the general impressions which I had at the time. Since the date of my correspondence with Mr. Betts I have become acquainted with a number of publications which describe processes for making such carbons which were then unknown to me. Those which occur to me are the processes of Scott

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Sidot, the process of Gaudoin as described in the certificate of addition to his French patent. Also, I have learned that Carré had made carbons for incandescent lighting whose diameter was only a millemetre or even a half millemetre.

108 R-d Q. At the time of your correspondence with Mr. Betts, did you know, either from experience or theoretical calculations, how high the total resistance
7734 of a lamp must be to enable it to be used in large numbers in multiple arc?

A. I did not know this, nor did I make any calculations regarding it.

109 R-d Q. Taking Mr. Betts' test of high resistance as given in his letter to you (to wit "whether a given lamp can or cannot be worked in large numbers in multiple arc without the employment of main conductors of large dimensions") what is your present
7735 opinion as to whether the Maxim lamp then submitted to you was a lamp of high resistance?

A. In my opinion, based on my present knowledge, the United States Co.'s lamp then submitted to me was not a lamp of high resistance, according to the criterion suggested by Mr. Betts. I am certain that such a lamp could not possibly be employed in large numbers in multiple arc for incandescent lighting in competition with gas or other illuminants. Any such arrangement of a large number of these lamps would require the
7736 employment of conductors of such large dimensions as to render competition with gas quite out of the question.

110 R-d Q. Did you in considering the question submitted by Mr. Betts, take into account the earlier incandescent lamps which made use of the metals as burners?

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A. I did not, as I understood the question which I was asked to consider to relate solely to earlier lamps employing carbon burners.

111 R-d Q. Did you in that connection consider the English patents of Lane-Fox in evidence, or the article of Lane-Fox in the London *Times* also in evidence?

A. I did not. I was not acquainted with either of these until within a year or thereabouts.

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112 R-d Q. Lane-Fox in his article in the London *Times* of December 26, 1878, in speaking of the distribution of the electric current for the purpose of lighting large areas with incandescent lamps, says that "In order to attain the proportionate conductivity referred to above, in a district, say, of 6,000 houses, the supply conductors for lighting alone would probably vary from one to three inches in diameter." What in fact would be the size of conductors necessary to-day
for supplying the area thus designated by Lane-Fox, 7739
assuming the resistance of the lamps to be not less than 100 ohms each, and assuming the system of distribution of the current to be that which was in use at the date of the patent in suit?

A. I have made an approximate calculation which goes to show that the figures given by Lane-Fox are substantially correct. The area covered by 6,000 houses would probably be not far from a square mile, and assuming the lighting station to be at the centre
of this square the average distance of the lamp from 7740
the central station would be at least one-quarter of a mile, and probably decidedly more than this. Assuming the fall of potential ten per cent. given by Lane-Fox, and also assuming that there are four main conductors starting from the central station, my calculation would give for the diameter of these conductors about 2 8-10 inches. If the average distance of the lamp is

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something over one-quarter of a mile, the conductors would reach the diameter of three inches.

> Defendant's counsel states that he proposes to examine the witness as to the various publications offered in evidence by complainant's counsel during his cross-examination of the witness, but in doing so he proposes to examine him *de bene*, and without waiving the objections applicable to the said publica-
> 7742
> tions or any of defendant's rights in the premises.

113 R-d Q. On cross-examination, in cross-questions 87 to 100, your attention was called to various publications of the years immediately preceding and following the date of the patent in suit.

Have you examined these publications, and if so, do you find in them anything which is opposed to the views that you presented on your direct examination,
7743 to the general effect that certain features of the lamp of the patent in suit are the result of the application of the well known laws of electrical energy, and therefore do not involve patentable novelty; and further, what is the nature of those publications as bearing upon the apparent assumption of complainant's counsel that the scientific men of that day were of the opinion that the subdivision of the electric light was impracticable?

A. I have examined the various publications referred
7744 to in the question with care, and find nothing in them whatever which is opposed to the views which I presented in my direct examination. On the contrary, many of them are very strongly and explicitly confirmatory of my assumption that certain features of the Edison lamp under consideration are the result of fundamental and well recognized principles of electrical engineering.

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It is very true that when the possibility of a general introduction of the incandescent electric light as a competitor with gas was first seriously considered, the project was looked upon as somewhat visionary by many persons, and with perfect justice, for even at the present day, with the multitude of devices other than a good lamp which have had to be invented or applied to make the service at all satisfactory, the incandescent lamp cannot compete with gas in the matter of price. It presents manifest advantages because of which a small portion of the public is willing to pay 7746
more for it than for gas, and it is really because of these advantages that it has come to be used even to its present comparatively limited extent. If I am correctly informed, the number of incandescent lamps at present in use in the United States, is only about five per cent. at the outside of the number of gas burners.

So far as I am aware, those best competent to judge, did not question the possibility of multiplying the electric light, that is, of producing many lights from a single machine; but they either simply considered that 7747
it would not pay, or in some cases imagined that difficulties would be found in the production of electricity in large quantities by dynamos, in suitable regulation of these, in the permanence of the incandescent burner, or in the liability of danger to life or property. The doubts entertained did not relate simply or particularly to the lamp required, but to the whole engineering problem. With those best informed, the questions which arose were of this nature, and were of the same character as those which were raised when 7748
Sir Humphrey Davy ridiculed the distribution of gas, when the possibility of trans-Atlantic steam navigation was doubted, when the possibility of bridging the East River or the Firth of Forth was questioned. But all of these, including the distribution of electricity, are matters of engineering, regarding which the theoreti-

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cal essentials to success were readily calculable from existing data. The question always was whether the theoretical necessities could be fulfilled, and whether, even if these were fulfilled, the enterprise could be financially successful. Moreover, in addition to the questioning that naturally existed as to the commercial practicability of very extended multiplication of the incandescent electric light, there was universal scepticism existing, and very justly, as to Mr. Edison's pro-
7750 jects in consequence of the wild and absurd statements that were put forth by various journals in articles which purported to express his views. As a sample of these I refer to the statements given in the *New York Sun* article re-published in the *Telegraphic Journal* for October 15, 1878, pages 414, 415.

Such pretensions could not fail to call forth energetic denials of the possibility of the success of such schemes, and did much, moreover, to prejudice Mr. Edison's later work in the eyes of many sober men
7751 who came to look upon him as a visionary enthusiast. Nor was this distrust removed, when, on the appearance of more definite statements of his invention, this was found to comprehend a system having for a generator of electricity an impossible dynamo, and for the lamps a burner of metallic wire involving the necessity of a clumsy regulator which was to be attached to each lamp.

It was baseless rumors as to what this apparatus was going to do which caused the absurd panic in gas
7752 shares, and it was this which almost everyone of the various writers cited in the cross-questions referred to in the present question had under consideration, so far as Mr. Edison was concerned. It is this apparatus which is figured and described in the article in the *Engineer* for February 14, 1879, page 113 (this being the article referred to in x-Q. 100), and regarding which that journal says:

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"All anxiety concerning the Edison light
" may be put on one side. It is certainly not
" going to take the place of gas, and its in-
" vention would not have been regarded with
" the anxiety and interest which have been
" displayed had it not been for the state-
" ments of newspaper reporters on the other
" side of the Atlantic."

And certainly no one would question to-day the
truth of the remarks quoted. 7754

It is the same device which is referred to by Prof. Sylvanus Thompson in his letter to *Engineering* (Complainant's Exhibit Thompson's *Engineering* letter of Oct. 25, 1878) and in his lectures (Defendant's Exhibit Thompson's *Engineering* Lectures, Dec. 20-27, 1878), and by the various witnesses before the British Parliamentary Commission referred to in the cross-questions mentioned in the present interrogation.

That the universal opinion of scientific men on the 7755
subject under consideration was by no means to the effect that extended multiplication of the incandescent light was impossible even commercially, is shown by the testimony of the witnesses examined before the British Parliamentary Commission in the spring of 1879. While they all realized the practical engineering difficulties in the way, they agreed almost without exception that such multiplication was possible. This will be clear from a few citations of the opinions of
those especially referred to in cross-question 97. 7756

In the printed minutes of the testimony of Mr. Conrad Cooke, the editor of *Engineering*, on page 47, question 338, I find the following:

"338. Have you given attention to the ques-
" tion of obtaining light by means of incan-
" descence, necessitating a closed circuit?—
" I cannot speak with any practical experi-

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"ence of that. My view of it is that you "would have a far greater loss; it could not "be done so economically, but it would prob- "ably be applicable in cases where economy "was not so much an object, and where there "was some special reason for dividing it."

Also on page 51, question 425, I find the following:

"425. Dr. Siemens, in referring to Mr. "Edison, who is credited with having recently "invented a machine for subdividing the
7758 "light, expressed some doubt on the subject, "and stated that he thought that it was not "as promising as the reports indicated; do "you know anything about that?—We really "know very little at all about it. A few news- "paper paragraphs have appeared on the sub- "ject, and I have been very much interested "as everybody has. His nephew told me, "himself that he has seen, I think, over 200
7759 "lights in one circuit. I must say I should "like to see it myself, and that is all that I "can say."

In the evidence of Mr. Preece before the same Commission, page 66, questions 515, 516, I find the following:

"515. Then, according to your view, the "electric light is really very economical when "it is used for giving central lights, but not "when it is used in a subdivided form?—It
7760 "is only economical when one machine is "used to produce a single light.

"516. And any departure from that "means waste, economically speaking? "Certainly.

In the testimony of Mr. Siemens, pages 29 and 30, questions 258, 259, 260 and 261, and page 31, question 276, and page 33, question 297, I find the following statements:

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"258. Then, as to its application to dwell- "ings, it would, I suppose, be a work requir- "ing some further experiment and a work of "some difficulty, before you could hazard an "opinion as to its being used in dwellings "generally instead of gas. For instance, the "expense of keeping the carbons and all the "machinery in order would almost prohibit "its being used generally in dwellings, would "it not?—There would not be much machin- 7762
"ery if central pumping or power stations "were adopted. The consumer would only "have his electric candle or his electric lamp "to keep in order, and that would not involve "any very serious difficulty. But if you sub- "divided the electric light, I think it perhaps "would become an expensive light.

"259. Has your attention been called to "some of the more recent experiments of Mr. "Edison, and to the success which he is 7763
"stated to have achieved in subdividing the "light, and making it applicable for rooms "and dwellings, and so on, with great ease "and cheapness?—I have, and I think Mr "Edison can, no doubt, produce by his means "a very steady, and possibly an agreeable "light.

"260. And a cheap light, he claims, I be- "lieve?—Dynamically speaking, I think, he "has to prove his case as yet. Our experi- 7764
"ence, as far as I can judge from my own, "leads me to an opposite conclusion.

"261. That is, to a conclusion opposite to "that which is said to have been the result "of Mr. Edison's recent experiments?—Yes. "The dynamo-machine which Mr. Edison "proposes, I think, is not promising.

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"276. (Earl Percy). You said that the
"electric light is cheaper, the more it is con-
"centrated; am I right in understanding that
"the loss of power depends upon the subdi-
"vision of the light rather than upon the dis-
"tance which the current has to travel?—
"Both of these conditions have their effect
"The distance to which a current has to
"travel would only increase the resistance if
7766 "the conductor was not increased; but if I
"had to increase my distance to, say, twice
"the distance originally existing between the
"source of power and the electric light, and
"I made a long conductor of twice the area,
"then the electric resistance would be the
"same in both cases, and the loss would be
"the same. Distance does not *a priori* im-
"ply loss of power; it implies weight of con-
"ductors; but subdivision of the electric
7767 "light implies a loss which cannot be ob-
"viated. In dividing the focus of light into
"two foci, each of these two foci would not
"give the amount of light produced by the
"original focus?
"297. You would say that for such pur-
"poses as footlights and sidelights, which re-
"quire constant modification of the light, at
"present at any rate, whatever your exper-
"ience may lead you to in the future, the elec-
7768 "tric light is hardly a suitable light?—Such
"a light, for instance, as Mr Edison proposes
"now, I think, would be much more control-
"able in that respect than the electric arc.
"The electric arc cannot be varied in its in-
"tensity and brilliancy so readily as gas;
"but if the light is produced by igniting a
"piece of iridium or platinum wire, then it is

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"easy enough to modify the current so as to
"give only a small amount of radiated light.
In the testimony of Professor Tyndall, page 12,
question 78, page 13, question 93, and page 14, question
105, I find the following statements:
"78. Have you, from a scientific point of
"view, paid attention to the experiments re-
"ported to us as having been made in America
"by Mr. Edison?—I have paid a good deal
"of attention to that subject. Mr. Edison is 7770
"an uncommonly clever man, and although
"one sees very serious difficulties in his way,
"one would be hardly entitled to say that he
"will not overcome those difficulties; but I
"do not know that he has up to the present
"time overcome them."
"Could not that be improved upon by
"using platinum, or iridium, or some other
"substance than carbon?—I am afraid, as re-
"gards public illumination, incandescency 7771
"will not do; the expenditure would be too
"great. The intense light is produced by the
"partial separation of the carbon points.
"The current, as the Chairman remarked at
"the beginning, requires a certain resistance
"in order to produce light. In the case of
"the electric light, this resistance is a space
"of air over which the current has to leap,
"and it is in gathering up the force necessary
"to leap across that interval that it is en- 7772
"abled to give us that intense light. In a
"continuous circuit it would involve the ex-
"penditure of an enormous amount of elec-
"tricity to attain the same amount of lumi-
"nosity."

"105. You showed us the ignition of plat-

7773 "inum wire by the passage of the electric "current; have not experiments been made "to use the ignition of such a wire and inferior conductors, or of alloys with iridium, "and so on, with a view of using that as the "source of electric light, instead of the carbon points:—I do not know that that has "been proposed with regard to public illumination, but I remember with the greatest
7774 "distinctness, more than 30 years ago, seeing "a lamp formed upon that principle and exhibited in Manchester. The incandescence "of platinum wire by the electric current "was known before Davy made his experiments in 1810. Children raised platinum to "incandescence by his battery; and at the "time to which I refer, I saw a very pretty "lamp on a table in Manchester ignited by the "voltaic current; but I do not know that that "has been produced for public illumination:
7775 "I believe that the waste of electricity would "be inordinate with a continuous conductor.

In the testimony of Mr. Hopkinson, page 76, questions 622, 632, page 77, question 633, and page 78, question 650, I find the following statements:

"622. What is the reason that a large "electric arc, produced, say, as a central "light by a single machine, gives you a con-
7776 "siderably greater illuminating power than "when it is divided into small electric arcs? "It is no doubt due to the higher temperature to which the substance of the carbon "is raised."

"632. I understand, generally, that you "consider that mechanical power is satisfactory for the production of the energy; but

7777 "that the application of it by means of showing a light is still far from being perfect or "satisfactory?—The greatest loss occurs in "the change from the stored-up energy in "the gas or the coal into the mechanical energy which the steam engine or gas engine "produces. There is a very large loss. It is "but a small percentage of the equivalent of "the heat of combustion of the gas which "actually becomes mechanical power.

7778 "633. With regard to the electric light, "the machinery now known for producing "the energy is very much more advanced "than the means of displaying that energy "by carbons or lamps?—Undoubtedly that is "so."

"650. (Sir Ughtred Kay-Shuttleworth.) As "I understand it, the real expense of the iridium light consists in this, that the iridium 7779 "being a continuous conductor there is "great waste of power in the consequent "flow of electricity from which you are getting no light?—The real loss in these incandescent lamps lies in this, that the temperature cannot be driven to so high a "point as when the electric arc is used; but "not even iridium, which has, perhaps, the "highest fusing point of any metal, will "stand the temperature of the electric arc 7780 "without melting or being volatilized.

In the testimony of Sir William Thomson, page 177, questions 1753, 1754, 1755, 1756, page 180, questions 1779, 1780, page 186, questions 1848, 1849, I find the following statements:

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"1753. If, then, the electric light is such
"an economical producer of the waves that
"we call luminous rays, do you consider that
"the electric light has a great future before
"it or not?—A great future. In the immedi-
"ate future I anticipate a great extension of
"the practical usefulness of the electric light.
"In a future somewhat less near, I antici-
7782 "pate the use of the electric light for every
"case of fixed lights, whether in large rooms
"or in small rooms, or in great public halls
"or in passages and staircases leading to
"them, and even in fixed lights in the lobbies
"and staircases of private houses.
"1754. Then you think that the use of the
"electric light is not the dream of a savant,
"but a practical possibility in the future?—
"Certainly. The electric light has been in
7783 "dreamland for 60 years, and it has now
"come into the world of realities.
"1755. And it is now rapidly progressing?
"—It is now rapidly progressing, and in good
"hands. A great deal of good work is spent
"upon it at this time, and there is immense
"promise in the work that is now being
"carried on by practical men upon the electric
"light.
"1756. Your reason for supposing so is,
"that there is now a prodigiously greater
7784 "economy in the transformation of mechani-
"cal force or energy into light than there for-
"merly was?—That is my reason.
"1779. Would you allow me to ask you
"about the division of the electric light into
"various small lights; scientifically do you
"agree with calculations the result of which

"have been put before us, that the effect of a 7785
"division must be, in some cases, to decrease
"the light so divided, according to the
"squares, or according to the cubes of the
"distance?—We have no scientific law of the
"economy of the electric light in different
"degrees of division and concentration; but
"practice and theoretical guesses seem to
"agree in making the economy much less
"when we spend the same quantity of energy; 7786
"for example, in ten feebler lights than when
"we spend it in one strong light; when we do
"this we do not get nearly one-tenth part of
"the whole light, by any of the plans hither-
"to in use.
"1780. But there is nothing in the mathe-
"matical discussion of the question that
"should render that reduction necessarily by
"the square or the cube?—No; it is quite
"possible that a plan of using electric energy 7787
"for light might be found and may yet be
"found, in which ten feebler lights will give a
"sum of light equal to that obtainable by the
"same energy in one concentrated light.
"1848. Supposing that we had a lamp in a
"dining-room, and that after dinner I did not
"want that lamp any more, how should I put
"it out?—If there are other lamps in series
"you would do it by short-circuiting it. It
"may be short-circuited through a resistance, 7788
"but then there will be a waste of light.
"1849. Then there is the same cost for that
"lamp as when it was burning with the ex-
"ception of the carbon?—Yes, but with
"proper regulators by inventions not yet
"made, the machine will have a governor, ac-
"cording to which, when you short-circuit

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"without resistance any one of the lights, the
"machine will not give more current than you
"want for the other light or lights, whether
"in the same circuit or in parallel circuits."

It will be observed that the testimony of the three experienced electrical engineers who testified before the Parliamentary Commission, Messrs. Thomson, Siemens and Hopkinson, is distinctly to the effect that the "subdivison" of the light (in the sense of its multi-
7790 plication) was unquestionably practicable, though in the opinion of some of them, likely to be costly; and in that last idea they were correct, although the great improvements in dynamos, systems of distribution, lamps, and other electrical devices, together with the advances in the efficiency of the steam engine, have doubtless reduced the cost below their expectations.

The articles to which I have just referred are the most important among those introduced as exhibits by complainant's counsel; but perhaps it will be use-
7791 ful, as indicating more clearly what was the belief in 1878 and 1879 as to the possibility of subdividing the electric light (in the sense of multiplying it), and the difficulties supposed to lie in the way of it, if I consider the remaining articles separately.

Chapter XI of Fontaine's "*Electric Lighting*" describes various forms of incandescent lamps. It also gives the results of dividing the definite current from the same battery among varying numbers of lamps, showing, of course, the loss that ensues by such
7792 division. I find nothing in the chapter, however, to indicate that the multiplication of lights with a proportionate multiplication of power was considered to be impossible, or from which anything could be inferred beyond a question as to whether it would pay commercially.

So far as the statements contained in chapter XII of

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Fontaine's "*Electric Lighting*" refer to the incandescent light, they go to show, not that its subdivision was considered to be impossible, but rather that it had already been actually accomplished by de Changy, as will be seen from the following statement which I quote. The statement is a communication made by M. Jobart to the French Academy of Science on the 27th of February, 1858. M. Jobart is mentioned by Fontaine as being "a thoroughly skilled man of science and one not likely to be carried away by the enthu- 7794
siasm of the inventor." Jobart's statement is as follows:—

"I hasten to announce to the Academy the
"important discovery of the dividing of an
"electric current for lighting purposes. This
"current from a single source traverses as
"many wires as may be desired, and gives a
"series of lights ranging from a night lamp
"to a lighthouse lamp.

"The luminous arc between two carbons 7795
"produces, as is well known, a very intense,
"flickering, and costly light. M. de Changy,
"who is a chemist, mechanician, and physi-
"cist, is thoroughly conversant with the
"latest discoveries, and has just solved the
"problem of dividing the electric light.

"In his laboratory, where he has worked
"alone for the past six years, I saw a battery
"of twelve Bunsen elements producing a con- 7796
"stant luminous arc between two carbons in
"a regulator of his own invention, this regu-
"lator being the most simple and perfect I
"have ever seen. A dozen small miner's
"lamps were also in the circuit, and he could
"at pleasure light or extinguish either one or
"the other, or all together, without diminish-
"ing or increasing the intensity of the light

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"through the extinction of the neighboring "lamps. The lamps, which are enclosed in "hermetically sealed glass tubes, are intended "for the lighting of mines in which there is "fire-damp, and for street lamps, which would "by this system, be all lighted or put out at "the same time on the circuits being opened "or closed. The light is as white and pure
7798 "as Gillard's gas, with which it has one point "in common, namely, its production by the "incandescence of platinum. The gas-pipes "are replaced by simple wires, and no ex- "plosion, bad smells, or fires can take place.

"The trials that have been hitherto made "with the object of producing an elec- "tric light by means of heated platinum "have failed on account of the melting of "the wires. This difficulty has been over-
7799 "come by M. de Changy's dividing regulator. "The cost of the light is estimated to be half "that of gas. A lamp placed at the mast- "head of a ship would form a permanent "signal for about six months, without the "necessity of changing the platinum. With "several such lights placed in tubes of col- "ored glass it would be easy to telegraph by "night, as they could be extinguished and re- "lighted rapidly from the deck. For light-
7800 "house purposes considerable amplitude can "be given to the light. I also saw a lamp so "arranged in a thick glass globe, that it "could be immersed to considerable depths, "without being overturned by any move- "ment. This lamp had already been used in "the taking of fish, which were attracted "towards the light.

"The above slight description will suffice

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"to show to what a variety of applications "this discovery can be put. The communi- "cation which I have had the honor of lay- "before the Academy is founded upon no il- "lusion. A lamp was to my astonishment lit "in the hollow of my hand and remained "alight, after I had put it in my pocket with "my handkerchief over it."

In chapter 10 of his book, "*The Electric Light*,"
Higgs considers the subject of the division of the 7802
electric light in general, including both arc and incandescent lights within his statements. He refers to the law of diminution of heat and luminous effects when a given current is split into branches, and states truly that "*with a given current source*" (the italics are mine) "the division of the electric current is therefore anything but indefinite;" also calling attention to the corresponding fact that with gas there is also less economy with a number of burners than if the same
amount of gas were to be consumed with a single 7803
burner. He then describes the best known methods of the "subdivision of the lights," but in no way intimates that he considers this other than feasible.

The editorial in the *Telegraphic Journal*, October 15, 1878, is a somewhat jocularly written article of unknown authorship, which does not bear marks of much study or real consideration of the subject. It was written under the stimulus of the New York *Sun*
article already referred to, in which the most ridicu- 7804
lous claims were put forth as to the future of a form of the incandescent light which to every electrician was evidently quite impracticable. But so far was the author from thinking the multiplication of the electric light to be impossible that he distinctly states that "any day may see its accomplishment."

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The letter of Mr. Wm. Trant in *Nature*, November 21, 1878, so far as it relates to Mr. Edison's lamp, refers only to the incandescent platinum spiral, and moreover contains nothing whatever that is in any way original, almost all of his data being taken from Fontaine. He considers only that subdivision is too wasteful to allow of the use of the incandescent light for general purposes, and concludes that if all that Mr. Edison has done is to announce that he has divided
7806 an incandescent light "his discovery means very little," since "both the light and divisaibility were discovered long ago." But whatever his opinions may be, Mr. Trant is quite unknown to the electrical world, and the conclusions in his paper cannot be considered as of any authority pro or con.

The editorial in *The Engineer* for January 10, 1879, also of unknown authorship, presents no internal evidence of having been written by one really competent
7807 to judge of the possibilities of electric lighting, but the conclusion which the author reaches adverse to electric lighting is simply that it will not pay. He says that if all London is to be lighted "from a few stations," the cost of copper conductors will be too great to allow of its use, naming for their cost an enormous figure. Whether his calculation is exact or otherwise, there is no question that it would be commercially impracticable to light all London to-day from a few stations with 100-ohm lamps and a simple parallel circuit system of conductors. When I say
7808 "commercially impracticable," I mean that this could not be done without the use of conductors of enormous dimensions, costing probably at least as much as the sum mentioned in the editorial.

The author of the editorial further says that he does not question that Edison or others may give us the light in our houses, but that this can be done only by sub-

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mitting to an enormous reduction in the light furnished by a given current when concentrated in a single focus as one arc; and this is universally recognized as true at the present day.

The editorial in *Engineering* for February 14, 1879, describes the tuning-fork dynamo of Mr. Edison, and his early form of platinum lamp with the thermostatic regulator. The writer of the editorial does not regard this system as in any way solving the problem of com- 7810
mercial electric lighting, and expresses many well-founded criticisms upon the apparatus. That portion of the article to which complainant's counsel refers in cross-question 100 is only a single sentence from what is a very long article. From a consideration of this article it appears that the writer merely expresses his belief that such a lamp as he is considering would not solve the problem of subdivision on a great scale. The editorial further says that the dynamo machine forming a part of the system is probably the very worst 7811
magneto-electric machine ever made.

The lecture of Mr. Preece on the "Criteria of the Electric Light," is much in the line of his paper in the *Philosophical Magazine*, which I have already discussed in my answers to interrogatories 60 to 64, and all that he says is evidently based on the processes developed in that paper and is subject to those limitations, as indeed Mr. Preece distinctly recognizes in the present lecture. He also recognizes that the "multiplication" 7812
of the light, as he calls it, that is, the increase of the number of lights by the use of a correspondingly increased power, and the "subdivision" of the light which he is discussing, are two different things. It is the latter, that is, the production of a large number of lights with a given expenditure of power and with substantially the same great economy as can be attained

7813 with a single greater one, that he pronounces "an absolute *ignis fatuus;*" but he has nothing to say explicitly against the possible multiplication of lights, and regarding this merely remarks that no suitable machine for doing it on a great scale has been produced, and that the cost of copper conductors will necessarily be large, both of these being difficulties whose solution is distinctly a matter of electrical engineering.

The editorial in *Nature* for February 12, 1880, dis-
7814 cusses Mr. Edison's carbon lamp in the light of the description given in the *Herald* article. It does not say anything from which one can justly infer that the author considered the use of an incandescent electric lamp for general illumination an impossibility; but it does show that the wild reports as to the astonishing results possible with this burner were absolutely untrustworthy. The author does not believe that the lamps can be made at the low price suggested in the *Herald* article, or that the dynamo machines used had
7815 the high efficiency ascribed to them, or as to the exceeding cheapness of the light as set forth in the *Times* article; and the experience of the last ten years has fully justified his belief. Moreover, the writer sees nothing particularly novel in the Edison lamp, considering it as substantially the same as that of King or Lodyguine, the only difference being that Edison prefers a different *kind* of carbon, and he refers to the use of a high resistance in the lamp as being an obvious deduction from Joule's law, in which he takes precisely
7816 the position that I have assumed in my answers.

The articles from *La Lumiere Electrique* fail entirely to convey the impression that there is any peculiar *invention* in the use of a high absolute resistance in an incandescent lamp, or that the problem of the multiplication of the light was other than an engineering

7817 one. The earliest of these, Volume 1, page 2, merely states that more study of the problem cannot fail to lead to more satisfactory results, that the law of the square explains why there is so much loss in dividing the light thus, that much research is necessary to make the electric light a success, recognizes recent progress in the Werdemann lamp, and, so far from thinking the question insoluble, expresses the belief that shortly there will be such developments as to cause a partial transformation of public lighting. 7818

The second article in the number for January 1, 1880, is by Du Moncel. In it he refers to the *Herald* article, and remarks that the system therein described has nothing new in principle. He considers the lamp to be only a modification of that of King, Lodyguine and others, and while admitting that the lamp may be better than earlier ones, he remarks, nevertheless, that "it does not constitute an invention of the magnitude reported by the American journals." The objections 7819
which the article raises to the lamp are valid ones, the force of which has been strongly felt in subsequent work.

The third article, also by Du Moncel, *La Lumiere Electrique* for October 1, 1881, was written over a year later than the previous one. The writer refers to his former articles, and restates the fact that there is great loss in "subdivision." He then describes the lamp, and so forth, and says that the Edison system 7820
is not constituted by the lamp, but that it is the totality of his inventions,—dynamos, etc.,—that commands attention. This he considers as a fully developed system.

But he in no wise intimates that he considers the high resistance in the lamp or any of its peculiarities as a novel, noteworthy and epoch-making invention,

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giving the long-desired solution of the problem of incandescent lighting. Neither does he mention as of vital importance any of the peculiarities of the lamp particularly set forth in the Edison patent in suit. That the mere principle of high resistance in the lamp was not noted as any novelty, is clear from the various descriptions of Edison's platinum lamp when it originally appeared. No one, so far as I recall, alludes to this possession of high resistance as a novel feature
7822 of the invention, or treats it in any way as if it were other than a simple matter of adjustment.

Nor do I recall any publication of authority which recognizes this principle as other than a feature of adaptation of lamp to circuit, which is a pure matter of engineering skill, following directly from well known rules.

In further illustration of the views of the scientific world with regard to the matter of the practical multi-
7823 plication of the electric light, I will refer to a description given by Mr. Moses G. Farmer of work which he had done in that line as early as 1859. This description will be found in the *American Journal of Science* (currently known as *Silliman's Journal*), for January 1879, third series, volume 17, page 65. I will also in the same connection refer to an exceedingly interesting article of Lane-Fox, a letter published in the London *Times* for December 26, 1878. Both Mr. Farmer's and Mr. Fox's articles recognized distinctly
7824 the perfect possibility of multiplying the incandescent light, and the latter article shows a perfect comprehension of the exigencies of the problem.

I am further confirmed in my views that the scientific world did not look upon a lamp alone as necessary to solve the problem, and further that they did not look upon the lamp of the Edison patent in suit as giving anything approaching a complete solution of the prob-

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lem, from the fact that in various publications discussions were given of the Edison paper-carbon lamp described in the *Herald* article, and the probable value of it was estimated. This paper lamp was a very much better lamp than that described in the patent in suit, but there was the greatest scepticism exhibited as to its value, and many criticisms were made which were abundantly justified by the unsatisfactory performance of the lamp; all of which certainly shows that the appearance of the carbon lamp quite failed to remove the 7826
scepticism which existed in the public mind as to the feasibility of the incandescent light as a rival to gas. This is clearly shown in the statements by Du Moncel to which I have already referred; also by the statements made by Mr. Outerbridge in an article published in the Journal of the Franklin Institute, and already in evidence in this case. I find further confirmation of my views in an article published in *Engineering* for May 14th, 1880, volume 29, page 382, entitled "Edison's Horseshoe Lamp." It reads as follows:— 7827

> "We have at last a glimmering of truth
> "upon the real value of the carbon horse-shoe
> "lamp invented by Mr. Edison at the close of
> "last year. A very able article communicated
> "recently to the *Standard* narrated the fail-
> "ure of the carbon filaments and of the
> "vacuous globes to stand permanent use. We
> "now possess a careful scientific investigation
> "into the economic value of the light. These
> "results, though brief, are conclusive; and 7828
> "they confirm in every point the adverse
> "criticisms which we published (*vide* Engin-
> "eering, page 113 *ante*), when the authori-
> "tative article upon the light appeared last
> "February.
>
> "It appears that Mr. Edison, dis-
> "satisfied with the expressions of bitter dis-

7829 "appointment heard on every hand, called in "the aid of two prominent scientific gentlemen "to carry out an independent investigation of "his lamps and of the amount of power consumed by them in the production of light. "These gentlemen were Professor H. A. Rowland, of the Johns Hopkins University—"an excellent nomination—and Professor G. "F. Barker, an out-an-out partisan of Edison
7830 "(and professor of physics in the so-called "University of Pennsylvania) and author of "the work which so unworthily attempted to "rob Professor Graham Bell of his laurels for "the invention of the telephone. These "gentlemen visited Menlo Park only to find "the testing apparatus of a description too "rough for use and the dynamometer hopelessly out of order. Contenting themselves "therefore with an improvised laboratory experiment, they measured the light and the
7831 "heat respectively emitted by two lamps "coupled in series. Their calculations "brought out the result that when the lamps "were emitting from 10 to 13 candles' light, "the energy actually supplied by the steam "engine to the generator was at the rate "of one horse power for 76 candles' power. "When stronger currents were used, so as to "make the lamps shine with about 30 candle
7832 "power, the economy was greater, but the "carbon filament was speedily destroyed.

"They wound up their report with the following conclusion, 'provided the lamp can "be made either cheap enough or durable "enough, there is no reasonable doubt of "the practical success of the light, but this "point will evidently require much further "experiment before the light can be pronounced practicable.'

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"This was the closing sentence of the "article in *Silliman's Journal*, but we may "record it as a fact in journalism that the "*New York Herald*—the favored Edisonian "organ—in avowedly quoting from *Silliman's* "*Journal*, contrived to add the following sentence: "That Mr. Edison will finally overcome the difficulty, however, no one who "knows him can doubt."

"This, however, is not all. A much more "satisfactory series of exact tests have been 7834
"applied to an Edison lamp with all the finest resources of the Stevens Institute; the "actual resistance of the lamp and the "strength of the current flowing being directly measured. These experiments were "conducted by persons of no less eminence "than Professor Morton and Professor "Mayer. Their report on these experiments "we hope to publish *in extenso* shortly; from "it, it would appear that though they found 7835
"the efficiency of the lamp experimented "with, even greater than those tried by Professors Rowland and Barker, they emphatically conclude that the disadvantages of "the system outweigh its advantages and its "'relatively trifling economy disappears or "ceases to have any controlling importance "in the practical relations of the subject.'

"The sounder judgment of American science, therefore, accords with that on this 7836
"side of the Atlantic in its estimate of that "which Mr. Edison modestly called 'my discovery of the electric light.'"

114 R-d Q. Among the papers put in evidence by complainant's counsel this morning is the translation of an extract from a publication made in 1888 by one

7837 Hippolyte Fontaine, in which the said Fontaine expresses the opinion (but without setting forth the facts upon which the opinion is based) that Mr. Edison is the true creator of incandescent lighting and is one of the benefactors of mankind. What, if anything, do you find in the extract contained in that paper that establishes any connection between this judgment that Fontaine passes upon Edison and the invention which is covered by the patent in suit.

7838 A. There is nothing whatever contained in the paper referred to which relates to the invention covered by the patent in suit, or which even indicates that the lamp of this patent was known to Fontaine. The Edison lamp to which he refers is the bamboo lamp which was devised by Mr. Edison a considerable time after the date of the patent in suit, and which differs from the lamp of this patent in important particulars. Still further portions of the immediate context which are not included in the paragraphs of Fontaine's book
7839 quoted in the exhibit, show that Fontaine's high estimation of Mr. Edison is not by any means based upon his invention of an incandescent lamp, but upon the various inventions relating to incandescent lighting which he attributes to Mr. Edison. Thus on page 101 of the same book I find a statement which I translate as follows:

"Mr. Edison has not confined himself to "inventing an incandescent lamp and to devising a dy- "namo suitable for use with great installations; he has
7840 "studied out a whole series of accessory apparatus and "has presented to the public a complete system of "electric lighting. It is especially this compact as- "semble which has led to the success of the method, "and which has rapidly brought the incandescent light "into real comparison with gas and with all other "known sources of artificial light.

"At the exposition of 1881 at Paris there was a genu-

7841 "ine surprise which was quickly transformed into admi- "ration when the representatives of Mr. Edison were "seen to install steam engines, dynamos, lamps, special "commutators, chandeliers, fixtures, a special system of "conductors, junction boxes, cut-outs, current regula- "tors, electrical meters, etc., etc., all having the appear- "ance of practical apparatus suitably co-ordinate and "detailed; everything working regularly, with certainty, "economically."

7842 115 R-d Q. I suppose that you do not know that Fontaine at the time of writing his book in 1888 may not have had a large pecuniary interest in the Edison inventions in France. How is that?

A. I have no knowledge to the contrary.

Re-cross examination by Mr. Dyer:

116 R-x Q. Have you any knowledge at all upon the subject inquired of in the last question?

A. I have not. 7843

117 R-x Q. Is it not a fact that the Maxim lamp which you examined and reported upon in June, 1881, was in all substantial or material respects like Complainant's Exhibit Defendant's M Lamp?

A. So far as I recall the former lamp, this was the case.

CHAS. R. CROSS.

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Defendant's counsel offers in evidence an article published in the London *Times* for December 26, 1878, the same being a letter

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from St. George Lane-Fox, and heretofore referred to by the witness Cross, which is marked "Defendant's Exhibit Lane-Fox Letter to London *Times;*" also an article printed on pages 65 and 66 of Vol. 17, third series, of the *American Journal of Science and Arts* (*Silliman's Journal*) which is marked "Defendant's Exhibit *Silliman's Journal* Article;" and also an article published in *Engineering* for May 14, 1880, which is marked "Defendant's
7846 Exhibit *Engineering* Article of May 14, 1880.

It is stipulated that typewritten copies may be used in place of the original publications, and that the various articles referred to were published at the times above stated.

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New York, March 4, 1890.

Met pursuant to adjournment.

Present:—Clarence A. Seward and Richard N. Dyer for complainant; Samuel A. Duncan and Leonard E. Curtis for defendant.

George W. Hebard called as a witness for the defendant and being first duly sworn, testified as follows: 7850

1 Q. What is your name, age, residence and occupation?

A. George W. Hebard, 45 years, 590 Greene avenue, Brooklyn, New York; occupation, President United States Electric Lighting Co.

2 Q. How long has the United States Electric Lighting Co. been engaged in the business of electric lighting? 7851

Question objected to as immaterial and irrelevant, and on the further ground that there is no allegation in the answer that authorizes or justifies the admission of the evidence.

A. The Company was incorporated June 10, 1878, and has been engaged in the business either experimentally or otherwise from the outset. 7852

3 Q. Please indicate what the resources of this Company were during the earlier years, if you please, down to the year 1885, when the suit was brought?

Same objection.

A. The capital stock of the Company on October 4th, 1880, was $600,000, and was increased from time to

7853 time until November 1882, when it was $1,500,000, of which $530,000 was issued for property and patents, and $970,000 was issued for cash, much of it having been sold above par and netted to the company $1,277,-750; and, in addition to this capital stock the earnings of the company were used in part and something like $1,000,000 was borrowed for the purpose of the business?

7854 4 Q. Please give some idea of the volume of business done by the company in its early years; if you please, in the years 1880 and 1881?

Same objection.

A. The sales for the year ending March 31, 1881, were $109,947.65, and for the year ending March 31, 1882, the sales were $798,744.59.

5 Q. Can you state what your sales of incandescent
7855 lamps were for the year 1881?

Same objection.

A. For the year ending March 31, 1882, our sales were 36,437 lamps.

6 Q. How many patents approximately are owned by your company?

Same objection.

7856 A. On the first of January, 1889, the United States Co., owned 303 patents.

7 Q. How many of these patents relate especially to incandescent lighting?

Same objection.

A. 170.

8 Q. How many patents relating to incandescent lighting had been taken out or been purchased and owned by your company prior to the year 1885? 7857

Same objection.

A. 131.

9 Q. State whether your company was notified by the Edison Company prior to the bringing of the bill
in this suit that it was infringing the Edison patent 7858
No. 223,898?

Same objection.

A. No, sir; not that I ever heard of. A circular letter was received from the Edison Co., reciting a list of their patents, I think about the middle of June, 1882; and under date of November 9, 1882, an additional list of patents were noticed in a letter signed by C. Goddard, secretary of the Edison Electric Light Co. So
far as I can remember or ascertain, these are the only 7859
notices ever received from the Edison Company. I now produce copies of these two notices, one of them being the original notice as received.

Defendant's counsel offers in evidence the two notices offered by the witness and the same are marked respectively Defendant's Exhibit Edison Company's Notices, Nos. 1 and 2.

10 Q. Please state whether there are other suits 7860
brought by the Edison Co., the plaintiff in the present suit, for alleged infringement of any of its patents against your company or its licensees and now pending in this Circuit, and if so, how many?

Same objection.

A. This suit is one of thirty that were instituted

7861 in May, 1885, against The United States Electric Lighting Co., and its licensees.

11 Q. Were these the first suits brought by the Edison Co. against your company?

Same objection.

A. Yes, sir.

7862 12 Q. How many different patents are involved in the suits so commenced against your company and its licensees, and what are they?

Same objection.

A. Fifteen different patents, to wit:

	No. 223,898,	No. 227,229,	No. 265,777,
	" 230,255,	" 266,447,	" 239,149,
	" 239,153,	" 248,419,	" 264,698,
	" 248,424,	" 263,140,	" 265,311,
7863	" 251,554,	" 288,318,	" 307,029.

These patents were all granted to Thomas A. Edison except one, which was granted to William Holzer.

13 Q. What was the character of the incandescent lamp that your company was making in the year 1881, and of which you say you sold between March of that year and April of 1882, some 36,000?

A. It was a lamp with an M shaped carbon and of
7864 about 40 ohms resistance hot, and of 16 candle power, being substantially the same as Complainant's Exhibit Defendant's M shaped Lamp, in evidence in this case.

14 Q. Please state whether you ever undertook to use this lamp in central station lighting, and if so, when first, and with what success?

A. To the best of my recollection, and from the best

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information at my command, The United States Electric Lighting Co. started an experimental station at 120 Broadway in the City of New York in November, 1880. They ran a circuit from 120 Broadway to Wall street and vicinity, adding lights from time to time until they were supplying 231 lights, distributed among seventeen different customers. The lamp before referred to was used for this service.

The company found it impossible to do a remunerative
commercial business with this lamp for the reason that, 7866
although they had provided a large cable for conducting the current to the lamps, the loss upon the line was so great as to cause a great variation in electro-motive force in the current supplied to the different customers and a very large breakage of lamps in consequence, although the lamps in the building showed a satisfactory life, and, after continuing the service for something more than one year, the experiment was abandoned.

A somewhat similar experience was obtain- 7867
ed from a station at the corner of Sixth avenue and Twenty-fifth street, from which place circuits of heavy wire were run over to Madison Square and lights added until there were 133 supplied to seven different customers. The experience at this station was not unlike that down town and the company abandoned it after keeping it in operation for a year or thereabouts.

These were the only central stations the company 7868
ever tried to establish with this M lamp.

15 Q. Taking your down-town station, what was the cost of light to the customer as compared with the cost of gas during the time the station was in operation?

A. It was very much in excess of the price of gas, as the customers were charged 1¼ cents per hour per

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lamp for the current and extra for the lamps and renewals. The cost of gas at that time would have been approximately one cent per hour per burner of equivalent power of illumination. Gas at that time was $2.00 per 1,000 feet, now it is $1.25.

16 Q. Has this M lamp been largely used by your company in isolated plants?

A. Yes, sir.

7870 17 Q. What, approximately, is the number of these lamps that you find it profitable to use in a single isolated plant?

A. The largest machine we ever made for use with these lamps was capable of supplying current for a hundred of them; I think in a very few instances two of such machines have been used coupled together, and it is possible that three have been coupled together, but I have no positive recollection. By coupling two ma-
7871 chines together, double the number of lamps could be supplied in the same circuit.

18 Q. Please state whether, in case you know, your use of the M lamp in 1880 and 1881 and subsequent years was known to the Edison Electric Light Co.

Same objection as to Q. 2.

A. I have reason to believe it was, for the Edison Company and the United States Company were in
7872 frequent and repeated competition for business during 1881 and afterwards, and for the further reason that the installation at 120 Broadway attracted a great deal of attention and many visitors, among whom was Mr. Edison himself, as I am informed.

19 Q. To what extent has the United States Electric Lighting Co. made use in multiple arc in central

7873

station lighting of lamps like complainant's exhibit "Defendant's Zigzag Paper Lamp?"

A. To no considerable extent.

20 Q. Please explain what you mean by this last statement.

A. I mean that in a few instances machines sold by us with this lamp have been used by purchasers to supply near-by customers with light to the extent of 250 lights or less, as we have never made a machine for use of these lamps of greater capacity than 250 7874
lights.

Cross-examined by Mr. Dyer *de bene esse* and without waiving objections.

21 x-Q. What was the capital stock of the defendant company when organized and how was it subscribed for?

7875

A. It was $250,000. I don't know how it was subscribed for.

22 x-Q. Was the amount issued for property in patents stated in answer 3, the proportion of the increased capital so issued?

A. It must have been, as only $250,000 was first issued; but as it was prior to my connection with the company, I have no personal knowledge on the subject. 7876

23 x-Q. When did your personal connection with the company commence?

A. November, 1881.

24 x-Q. You have no personal knowledge then of the affairs of the company before that time?

7877 A. I was a stockholder from the early part of the year 1879 and was connected with the house of Schuyler, Hartley & Graham, who controlled the Bridgeport Gun Implement Co., which company manufactured apparatus for the United States Elecric Lighting Company, and I had more or less familiarity with the business of the United States Company in consequence.

25 x-Q. Were you personally familiar before
7878 November, 1881, with the U. S. Electric Co.'s business, the character of its apparatus in use, and the limitations upon the use of the apparatus?

A. I was reasonably familiar with the apparatus made at that time.

26 x-Q. Do the books of the company show how the amounts of sales stated by you in answer 4, are divided between arc lighting and incandescent lighting, or do you know the fact from your own knowledge?

7879 A. The figures given in answer to Q. 4, are taken from the statistics compiled in our office, which do not discriminate as to what part was for arc apparatus and what for incandescent. As so long a time has elapsed I should dislike to express any opinion from memory, but the sales being shown in detail could be compiled from the books.

27 x-Q. What does the number of lamps given in answer 5, include. I mean does it include all the lamps you put out for use during the time mentioned
7880 in answer 5?

A. It means that that number of lamps were charged and shipped during the period named.

28 x-Q. Did it include also lamps used in exhibition plants?

A. Only lamps that were shipped and charged for are included in this number.

29 x-Q. Were not the lamps charged up to some account on the books even though used in exhibition plants? 7881

A. The lamps above referred to, to the best of my memory, were all sold and paid for; the lamps used in the exhibition plants above referred to being charged in each instance to the users of the light.

30 x-Q. What was the kind of apparatus that the Bridgeport Gun Implement Co. was making for the U. S. Co. in 1879? 7882

A. Dynamo machines, arc lamps, regulators, incandescent lamps, and other devices were made at Bridgeport for the United States Electric Lighting Co., during the year 1879 and afterwards. I cannot tell positively from memory what was made in 1879 and what in 1880.

Adjourned to March 5th at 10:30 A. M.

7883

New York, March 5th, 1890.

Met pursuant to adjournment.

Present—Counsel as before.

Cross-examination of George W. Hebard *continued:*

31 x-Q. In the business competition which you speak of in A. 18 as indicating that the Edison Co. probably knew of your lamps, did not your agents become acquainted with the fact that the Edison Co. 7884
claimed to have by its patents, including the patent in suit, a monopoly of the manufacture of incandescent lamps?

A. I cannot say as to the agents of the company, but through the public press and by advertisements, etc., the officers of the company were aware that the Edison Company claimed to own patents covering everything relating to electric lighting by incandescence.

7885 32 x-Q. And also that the incandescent lamps made by the U. S. Co. were claimed to be an infringement upon the Edison patents, including the patent in suit?

A. I am aware that the Edison Co. alleged that the lamps made by the U. S. Co. were covered by patents owned by said Edison Co.

33 x-Q. How early were the officers of the U. S. Co. aware of these claims and allegations?

A. I don't remember. It was a long time ago, and
7886 the statements being made in general terms it would be impossible for me to say.

34 x-Q. Did you hear of these things before you became personally connected with the affairs of the U. S. Co. in November, 1881?

A. In a general way, I should say that I was at that time, and perhaps before, aware of the allegations of the Edison Co. to the effect that any incandescent apparatus was made in violation of their rights.

7887 35 x-Q. In November, 1881, when you became president of the U. S. Co., what proportion of the profits of the business was due to arc lighting and what to incandescent lighting?

A. I never prepared any statistics and it would be impossible for me to give any intelligible information in reply to that inquiry, further than to say that the volume of business in arc lighting probably exceeded the volume of that done in incandescent lighting.

7888 36 x-Q. The arc lighting was then a very much larger part of the business of the U. S. Company, was it not, in profits?

A. Previously the volume of business in arc lighting had been considerably larger; but about the time that I became president of the company, or shortly before

that, the incandescent business had increased largely, and we were behind our orders for some months. As to the relation of profits, I have not the information to state whether the percentages were greater in the arc or the incandescent. 7889

37 x-Q. With reference to lamps like Complainant's Exhibit, "Defendant's M Lamp," were not these lamps used for lighting in multiple-arc by your company?

A. They were in small isolated plants, and in the 7890
experimental stations referred to in my direct testimony. The largest machines built by the U. S. Company for use with these lamps had a capacity for only 100 lights.

38 x-Q. Are lamps of the same character in use for multiple arc lighting at the present day?

A. Yes, sir, on some small isolated plants.

39 x-Q. What is the largest isolated multiple-arc 7891
plant, in number of lamps, that the U. S. Company ever installed with these M. lamps?

A. I think there were several isolated plants using two one-hundred light machines each, and it may be possible that one or two plants were installed of three one-hundred light machines, but I cannot state positively.

40 x-Q. Is it not a fact that in some instances wires were run from these isolated plants into one or more 7892
adjoining buildings for supplying current to these M lamps, in one or more buildings other than the building in which the dynamos were located?

A. Not that I am aware of.

41 x-Q. When did you begin to manufacture the 70-volt lamp like Complainant's Exhibit "Defendant's Zigzag paper lamp"?

7893 A. During the spring or early summer of 1883, to the best of my recollection.

42 x-Q. What character of work did you do with these 70-volt lamps prior to May, 1885 ?

A. We used them in connection with the plants for isolated lighting, and I think these lamps were used for multiple-series lighting prior to May, 1885 ?

7894 43 x-Q. Was the multiple-series lighting central-station lighting ?

A. In some cases.

44 x-Q. How were these lamps arranged in circuit for other than multiple-series lighting by your company ?

A. When used on isolated plants they were usually put up in multiple-arc.

7895 45 x-Q. Are lamps like these 70 volt lamps used for lighting in multiple arc at the present time. If so, how largely are they in use ?

A. They are largely in use for isolated lighting, at present, in multiple arc.

46 x-Q. What is the largest isolated plant, in the number of lamps, that your company has ever installed with these 70-volt lamps ?

A. I don't remember any of more than 1000 or 1200

7896 lamps ?

47 x-Q. In these larger plants which you refer to how were the lamps arranged in circuit ?

A. Multiple arc.

48 x-Q. On the same circuit ?

A. Sometimes.

49 x-Q. In that case it became necessary to couple your dynamos together, so as to deliver their current to the same circuit, did it not ? 7897

A. Yes, sir.

50 x-Q. What is the largest isolated multiple-arc plant your company has ever installed, and what character of lamps was used in it ?

A. The largest plant that I recall is the one in the Equitable Life Assurance Building at New York which has a capacity of 4,200 16-candle lamps, 110 volts. 7898

51 x-Q. This is the same building at 120 Broadway which you have before mentioned in connection with an experimental central-station plant ?

A. It it the same location, but the building has been torn to pieces and rebuilt since that time ?

52 x-Q. Did you formerly use a lower volt lamp in this building, and if so, when did you change to the 110-volt lamp?

A. The present plant was installed in the summer 7899 of 1883, if my memory serves me correctly. Previous to that, in the old building they used a plant equipped with the lower volt lamps.

53 x-Q. What was the voltage of these lower volt lamps, and how many were used ?

A. To the best of my recollection, there were 700 or 800 70-volt lamps used.

54 x-Q. And before that time did you furnish lights 7900 in the same building with the 60-volt lamps like Complainant's Exhibit "Defendant's M lamp?" If so, how many of these were used ?

A. After the experimental station plant referred to in the direct examination was discontinued, we sold

7901 the Equitable Life Assurance Company a plant of some 200 or 300 of the 40 ohm M lamps, which was afterwards replaced by the larger plant of 70-volt lamps before referred to.

Adjourned to meet at 12 o'clock March 7.

March 7, 1890.

Met pursuant to adjournment.

7902 Present: Counsel as before.

Examination of the witness George W. Hebard resumed.

Re-direct by S. A. DUNCAN:

55 R-d Q. In answer to 32 x-Q (which referred generally to the "patents" of the Edison Co.) you have said that you are aware that the Edison Company alleged (as I understand, at a time prior to the beginning of this suit) that the lamps made by the United
7903 States Company were covered by "patents" owned by the Edison Company. Please state whether, prior to the beginning of this suit, you were aware, or, so far as you know, any of the officers of the defendant corporation were aware, that the Edison Company claimed that the lamps of the United States Company were an infringement of the particular patent in suit, viz; No. 223,898?

A. I was not, and so far as I know, none of the other officers of the company were.

7904 56 R-d Q. In answer to 46 x-Q you have said that the largest number of your 70-volt lamps (being lamps like Complainant's Exhibit "Defendant's Zigzag paper lamp") ever installed in an isolated plant, was from 1,000 to 1,200. Please state how these lamps were arranged relatively to the dynamos, as regards the matter of distance?

A. Since giving the testimony referred to, I have learned that the plant in the New York Post Office building consists of seven or eight 250-light machines. 7905
But there, as in other plants referred to, the lights are largely massed near the machines; very few, if any, of the lights being more than 400 feet away from the machines, and the very large proportion of them, being in the basement and on the first floor, are not more than 200 feet away, many of them less.

57 R-d Q. You have stated on you cross-examination, in answer to 39 x-Q., that the largest plant of defendant's M lamps does not exceed 200 of such lamps, or possibly 300. In these plants employing the maximum number of M lamps, how near to the dynamo are the lamps placed? 7906

A. It would be impossible for me to state specifically without making examination; but from my general knowledge of the subject, I know that the dynamos are located with special reference to grouping 7907
the lamps near them, and to the best of my knowledge and belief, very few, if any, of the lamps are located more than 200 feet away from the dynamos; while the large part of the lamps are much nearer. The M lamp was largely used in small plants of 50 and 100 lights, as e. g. on ferry-boats and in small factories where the ights are not widely distributed.

Re-cross examination by MR. DYER:

58 R-x Q. Do you mean by the answer to 55 R-d Q., that you and the other officers of the defendant company did not know of the filament patent of Mr. Edison? 7908

A. I do not know which one of the Edison patents you or the Edison Company call the filament patent; but there was nothing in the drawings or specification

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of the patent No. 223,898, which bore sufficient resemblance to the lamps we were making to suggest to my mind any infringement.

59 R-x Q. Did not you and the other officers of the defendant company know of this patent No 223,898, and was it not a matter of discussion between the officers and counsel of the company ?

A. Not that I am aware of.

7910 60 R-x Q. You are not aware of the fact then that long prior to the beginning of this suit, this patent No. 223,898, was discussed between the officers and the counsel of the defendant company, in anticipation of a suit upon it, and that the defenses to this patent were carefull investigated by the officers and counsel for the defendant company at that time ?

A. No, sir.

7911 61 R-x Q. Are you aware of the fact that, at various times before the bringing of this suit, advances were made by or on behalf of the defendant company to the complainant company, to secure an arrangement with the complainant company under the patents of the complainant company, including the patent in suit ?

Objected to as immaterial.

A. I am not aware that any officer, employee or re-
7912 presentative of the defendant company was ever authorized to conduct negotiations with the complainant company for an arrangement under this or any other patent owned or controlled by the Edison Company prior to the commencement of this suit; although a large number of parties have come to the defendant company at various times, asking if a commercial ar-

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rangement of some sort could not be made between the competing companies to stop competition and unnecessary patent and legal expenses, there being numerous parties who apparently thought that money might be made for themselves, if, acting as brokers or intermediaries, they could bring about such a result. I am aware that also stockholders in the defendant company have on their own account, as individuals, had conversations with stockholders in the complainant company, presumably acting in like capacity, concern-
ing the advisability of some broad commercial arrange- 7914
ment, by which the two companies could work together in building up the electric lighting industry, rather than by competition destroying same; but that such conversations were on the broad subject as above stated, and did not relate specifically to the patent in suit, or any other patents or group of patents.

62 R-x Q. Were you present at those conversations?

A. In one or two instances.

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63 R-x Q. You don't know then, of your own knowledge, whether in the other conversations, the patent in suit was specifically mentioned or not ?

A. Only upon information and belief. And if they had been, the parties to the conversation were not authorized by the Board of Directors to act for them in any sense.

64 R-x Q. You do not pretend to include what oc-
curred in this relation, before your personal connection 7916
with the company in November, 1881, do you ?

A. Only so far as is shown by the records of the company, and upon information and belief.

65 R-x Q. Who was the president of the company before November, 1881 ?

A. Chas. R. Flint, immediately before, for one year or more, I think.

GEORGE W. HEBARD.

7917

NEW YORK, April 17, 1890.

Met pursuant to agreement of counsel at the office of Duncan, Curtis & Page, 120 Broadway.

Present:—Messrs. CLARENCE A. SEWARD and RICHARD N. DYER, for Complainant, and
SAMUEL A. DUNCAN and LEONARD E. CURTIS, for Defendant.

7918 Defendant's counsel offer in evidence a certified copy of the file wrapper and contents of the Edison patent in suit, which is marked "Defendant's Exhibit File Wrapper and contents of Patent in Suit."

Also a certified copy from the files of the Patent Office, of the patent in suit, which is marked "Defendant's Exhibit Patent Head of Patent in Suit."

Also a certified copy of the file wrapper and contents of United States Letters Patent No. 227,229, granted to Thomas A. Edison, May 4th, 1880, which is marked
7919 "Defendant's Exhibit File Wrapper and Contents of Edison's Patent No. 227,229."

Also a certified copy of the file wrapper and contents of an application filed by Thomas A. Edison December 11th, 1879, for improvements in electric lamps and method of making the same, which is marked "Defendant's Exhibit File Wrapper and Contents of Edison's Paper-carbon Application."

The drawing of said application December 11th, 1879, having been omitted from said certified copy, it
7920 is stipulated that the copy of the same now produced by defendant's counsel is a correct copy of the said drawing, and may be used in evidence in this case and inserted at the proper place in the printed record, subject to complainant's objection as stated below.

Each of said exhibits is objected to by complainant's counsel as immaterial, irrelevant and incompetent.

It is stipulated between the parties that on the 15th

day of November, 1878, an agreement was entered into 7921
between the complainant and Thomas A. Edison, of which the paper now produced by complainant's counsel is a correct copy, and may be used in evidence with the same force and effect as the original agreement, subject to the objection next hereinafter taken by complainant's counsel.

The said copy of the said agreement is offered in evidence by counsel for defendant and the same is marked "Defendant's Exhibit Agreement between Edison and Complainant of November 15th, 1878." 7922

Complainant's counsel object to the said agreement as irrelevant, immaterial and incompetent.

It is also stipulated that on the 12th day of February, 1880, the said Edison assigned the patent in suit to the complainant in accordance with the contract of November 15, 1878.

It is also stipulated that on the 1st day of June, 1880, the said Edison assigned the said Patent No. 227,229, to the complainant in accordance in accordance with the said contract of November 15th, 1878. 7923

It is also stipulated that on the 21st day of June, 1881, the said Edison assigned the invention covered by the said application filed December 11th, 1879, to the complainant in accordance with the said contract of November 15th, 1878.

It is also stipulated, as to the patent in suit and as to said patent No. 227,229, and as to said application filed December 11th, 1879, that on the request of the said Edison the expenses specified in said agreement
of November 15, 1878, to be paid by the said company 7924
were, by it, from time to time, and after the incurring thereof so paid, including the expenses of preparing, filing and prosecuting the applications for the said patents No. 227,229, No. 223,898, and said application filed Dec. 11th, 1879.

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Defendant's counsel offer in evidence an extract
from page 101 of "The Inductorium or Induction
Coil," by Henry M. Noad, published at London by
John Churchill & Sons in 1868, and the same is marked
"Defendant's Exhibit Extract from Noad's Inductorium."
Proof of publication is waived, and it is stipulated
that a copy may be used in place of the original
book.

Defendant's Counsel offer in evidence a copy of a
7926 certified copy of certain papers relating to the consolidation
of the corporation complainant with the Edison
Company for Isolated Lighting, filed in the Office of
the Clerk of the City and County of New York December
31, 1886, and the same is marked "Defendant's Exhibit
Edison Consolidation Proceedings."

It is stipulated that the paper offered by defendant's
counsel is a correct copy of the said consolidation proceedings,
subject to the correction of any errors that
7927 may be found therein at any time before the hearing;
that the original was duly filed and recorded as required
by the New York statute authorizing
said proceedings, and that the Edison Company
for Isolated Lighting, mentioned in said proceedings,
was a New York corporation created and organized as
therein stated.

Defendant's counsel also offer in evidence a copy
of an agreement dated March 8, 1881, between the
Edison Electric Light Company, the complainant, and
7928 Thomas A. Edison, and the same is marked "Defendant's
Exhibit Agreement between the Complainant and
Thomas A. Edison, of March 8, 1881."

It is stipulated that the paper offered in evidence
is a correct copy of the agreement executed between
the parties as therein stated subject to the correction,
at any time before the hearing, of any errors that may
be found therein, and that prior to bringing this suit,
the said agreement was duly assigned by said Edison

with the consent of the complainant to the Edison 7929
Lamp Company, a corporation organized under the
laws of the State of New Jersey.

Defendant's counsel also offer in evidence copies of
two agreements between the Edison Electric Light
Company, the complainant, and the Edison Company
for Isolated Lighting, dated respectively April 26,
1882, and September 1, 1884, and the same are marked
respectively "Defendant's Exhibit Contract between
the Complainant and the Edison Company for Isolated 7930
Lighting" and "Defendant's Exhibit Supplemental
Contract between the Complainant and the Edison
Company for Isolated Lighting." It is stipulated that
the papers offered in evidence are correct copies of the
original agreements executed between the parties, subject
to the correction, at any time before the hearing,
of any errors that may be found therein.

Defendant's counsel, with the consent of Complainant's
Counsel, withdraw the offers of the following exhibits
contained in the deposition of Mr. Man stipu- 7931
lated in from the McKeesport case, the said exhibits
being on file in said McKeesport case: "Specimens of
Excelsior, broom corn and manilla" referred to on page
442 of the printed record, "No. 29 Globe of Lamp" referred
to on page 452, "Specimens of Gru-gru Palm
and Mangrove," referred to on page 809, and "Specimens
of India Cane," referred to on page 822.

It is agreed that the "Exhibit No. 30" put in evidence
on page 460 of Albon Man's deposition is the
decision of the Commissioner of Patents printed on
pages 714 to 734, Vol. 4 of the McKeesport record, 7932
and that the typewriter copy of the same now produced
may be marked and used as such exhibit in this
case, subject to the correction of any errors that may
be found therein.

7933

UNITED STATES CIRCUIT COURT,

SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT COMPANY

vs. — In Equity No. 3,445.

7934 THE UNITED STATES ELECTRIC LIGHTING COMPANY.

Continuation of proofs in behalf of defendant, taken before S. M. Hitchcock, one of the Examiners of the Court.

NEW YORK CITY, Apr. 30, 1890.

Met pursuant to notice, at 2 o'clock p. m. at office of Duncan, Curtis & Page at 120 Broadway, and ad-
7935 journed to office of Seward, Da Costa & Guthrie, 29 Nassau street.

Present:—C. A. SEWARD, Esq., and R. N. DYER, Esq., for Complainant. S. A. DUNCAN, Esq., and L. E. CURTIS, Esq., for Defendant.

Counsel for defendant offer in evidence the following documents:

1. A copy in the Swedish language, duly certified under the seal of the Swedish Patent Bureau, of letters
7936 patent granted to Thomas Alva Edison by the Kingdom of Sweden on the 5th day of March, 1880, together with the description accompanying the same and forming a part thereof, the said patent and specification being marked by the Examiner as "Defendant's Exhibit Edison's Swedish Patent."

2. A copy, certified in like manner, of the drawing accompanying the said Swedish patent, the same being marked by the Examiner as "Defendant's Exhibit Edison's Swedish Patent Drawing."

7937

3. The stipulation made by and between the parties hereto under date of April 24, 1890, in relation to the aforesaid Edison Swedish Patent, and the Law of Patents of the Kingdom of Sweden; and the same is marked by the Examiner as "Defendant's Exhibit Stipulation *re* Swedish Patent Law and Edison's Swedish Patent."

4. The stipulation made by and between the parties hereto under date of April 25, 1890, in regard to the translation of the aforesaid Edison Swedish patent, together with the translation and drawings of the same; 7938
and the same is marked "Defendant's Exhibit Translation of Edison's Swedish Patent."

5. A copy of letters patent No. 10,654, issued by the Dominion of Canada to Thomas Alva Edison under date of November 17, 1879, for the period of five years, together with the specification and drawing accompanying the same, and the certificate of the Commissioner of Patents of Canada under date of October 30, 1883, in relation to the payment by the holder of said patent of a fee of $40, for the further term of ten years, 7939
the said copy being certified by C. J. Cambie, as Acting Deputy Commissioner of Patents of the Dominion of Canada, under the seal of the Department of Agriculture of said Dominion, on January 13, 1885; and the same is marked "Defendant's Exhibit No. 1, Edison's Canadian Patent." This is the same Canadian patent which was put in evidence on August 2, 1888, and was then marked as "Defendant's Exhibit No. 1," and is referred to under this designation in the depositions of Z. A. Lash and Charles Moss heretofore taken 7940
in this cause.

It is stipulated, subject to the correction of any errors that may hereafter be discovered, that this is a correct copy of the Canadian patent issued to the said Edison in Canada at the date aforesaid, and of the specification and drawings of the same, and of the cer-

7941 tificate of the Commissioner of Patents respecting the payment of the extension fee of forty dollars; also that the grantee of the said Canadian patent was the same Edison to whom the United States Letters Patent No. 223,898, here in suit were issued.

7942

Defendant's Exhibit, Stipulation re Swedish Patent Law and Edison's Swedish Patent. April 30, 1890. S. M. H., Ex.

CIRCUIT COURT OF THE UNITED STATES.

SOUTHERN DISTRICT OF NEW YORK.

7943 THE EDISON ELECTRIC LIGHT COMPANY vs. THE UNITED STATES ELECTRIC LIGHTING COMPANY.	In Equity No. 3445

It is hereby stipulated by and between the parties hereto, for the purposes of this suit, as follows:

7944 1. That letters patent were granted in the Kingdom of Sweden on the 5th day of March, 1880, to Thomas Alva Edison, the patentee to whom the United States patent here in suit was granted, as alleged in the amended plea and answer herein; and that the said patent and the specification and drawing accompanying the same and forming a part thereof, and descriptive of the invention thus patented, were as the same appear in the coppies of the same certified on Decem-

ber , 1889, and February 4, 1890, respectively 7945
by Wilhelm Swalin under the seal of the Royal Patent Office of Sweden, and marked herein as "Defendant's Exhibits Edison's Swedish Patent," and "Edison's Swedish Patent Drawing."

2. That either party herein is at liberty to introduce in evidence the Patent Laws of the Kingdom of Sweden as the same appear in the official publications in the possession of the Swedish Consul in the City of
New York, or a copy of the same certified by the said 7946
Consul; and particularly the Royal Decree respecting Patents of August 19, 1856, and the addition thereto of February 22, 1867. It is further stipulated that the translation hereto attached of the said Royal Decree of 1856 is a correct translation of the said original decree, and it is further stipulated that by the said supplemental decree of 1867 it was provided that the proof of working required by Section 10 of the said law of 1856 must establish that the working had been within the
Kingdom of Sweden. 7947

3. That on the 11th day of January, 1884, the College of Commerce referred to in the said Swedish law of 1856, acting under the provisions of Section 16 of said law, published in the Official Gazette of the Kingdom, viz: in the Post och Inrikes Tidningar, the notice required by the said section 16 of the said decree, in reference to the said Edison patent of March 5, 1880, on the ground that it had not been proven that the patented invention had been worked in the Kingdom
of Sweden within the year 1883, as required by law; it 7948
being agreed that the defendant furnish at the earliest practicable day a copy of the said notice thus published by the College of Commerce, duly certified by the American Consul at Stockholm, the same to be used in connection with and as a part of this stipulation.

7949

4. That the invention covered by the aforesaid Edison Swedish patent was not worked or employed in the Kingdom of Sweden within the third period of twelve months from the date of said patent, viz: during the twelve months preceding March 5, 1883; that the period of two years allowed by section 10 of the said royal patent decree of 1856 for making proof of the working of a patented invention in Sweden was not extended; and that no proof of working within the said third pe-
7950 riod of twelve months was made.

This last stipulation, as well as the previous ones, to be subject to the correction, upon due notice, of mistakes of fact, if any such shall hereafter be found to exist.

April 24, 1890.

EATON & LEWIS,
Solicitors for Complainant.

7951 DUNCAN, CURTIS & PAGE,
Solicitors for Defendant.

1856. No. 49. 7953

SWEDISH COLLECTION OF STATUTES.

(To be read from the pulpit.)

HIS ROYAL MAJESTY'S

RENEWED GRACIOUS DECREE CONCERNING PATENTS;

Given in Stockholm Castle, August 19th, 1856.

We, Oscar, by the grace of God King of Sweden, Norway, the Goths and the Wends, hereby proclaim as 7954
follows:

Whereas the States of the Kingdom have to us made humble presentment regarding certain changes in the Royal Patent Decree of December, 13th, 1834, and

Whereas, on gracious command, Ours and the National College of Commerce, guided by further experience, has prepared and presented humble proposition for a new Statute in this matter,

We have, after a hearing granted to those concerned, 7955
decided through this renewed decree graciously to establish the following rules regarding the granting and enjoyment of patents, or letters giving the right, with exclusion of others, during a certain time to practice and employ new inventions in industry and art, as well as improvements upon inventions of this nature already made:

SEC. 1.

Patent confers upon the owner the right during the 7956
time fixed by the letters patent, with exclusion of others, personally or through others, everywhere within the Kingdom, to practice that invention or produce those manufactures, specified by the patent, and to keep these products for sale; wherein it is his duty to comply with the rules established by present statutes regarding the manufacture and sale of goods, although

7957 he shall not be obliged in order to enjoy the right mentioned, to acquire the freedom of a trade or a city.

Patent-right shall be considered the owners legal property, and may accordingly be inherited and by means of any legal document whatever transferred to a second party, with the right that has been granted through the letters patent.

SEC. 2.

7958 Patent shall be obtainable:

1st: On new inventions having industry or art for their object; and

2nd: On improvements upon previous inventions of this nature, which however, must not lead to infringement upon patent-right previously granted.

Patent may not be granted upon medical preparation, nor upon invention of such a nature that its employment is evidently contrary to existing law, common
7959 safety or good morals.

Nor can anybody through a patent gain exclusive right of generally employing a new principle, but only of using that or those ways and means in the practising of an invention which by the applicant are stated and described.

SEC. 3.

Patent is granted for a time of at least three, and at most fifteen years, in proportion to the nature and
7960 importance of the invention.

SEC. 4.

To the obtaining of a patent in accordance with the rules above established only inventors, Swedish or foreign, are entitled.

SEC. 5.

If anybody has obtained a patent on his invention in

a foreign country, and thereby been forced to publish a 7961
description of the manner in which to practice the invention, he may, nevertheless, obtain patent in this kingdom for a certain length of time, in accordance with Sec. 3, no longer, however, than until the foreign patent expires.

SEC. 6.

Inventor desirous of patent may file an application with Ours and the National College of Commerce, and embody into the same, beside announcement of the 7962
matter in question, distinct statement whether the invention on which patent is applied for is new or an improvement upon an invention already in use, and also state the time during which the applicant wishes to enjoy patent right; he is also required to annex a correct and comprehensive description of the invention, and the manner in which it is to be practiced, and also correct drawings or models, where such are required. Such descriptions and drawings shall be submitted to the college sealed, the seal to be broken when the ap- 7963
plication for patent is taken up for consideration; then they are kept with the college in order to be accessible to those desirous of making themselves acquainted with them. If the applicant is unable to furnish a perfect description at once, such fact should be stated in the application. The college then shall, by an extract of the record to be publicly posted, grant the applicant a grace of one month from the date of posting, within which he shall file such description, and during this time the decision on the application shall be 7964
postponed. If he does not within this prolonged term file the description, the application shall be considered to be forfeited, yet the applicant shall not be prohibited from making a new application to the College about the same matter.

Application of the nature treated of in this section, shall, if applicant is not a resident of this Kingdom,

7965 be filed through a man domiciled in Sweden, whose name and residence shall at the same time be stated to the college for the purpose of registration, and who, if the application is to be taken up for consideration, has to file together with the application, applicant's power of attorney, prepared in writing, authorizing him to act and respond for him in everything pertaining to the patent question.

7966 Sec. 7.

When complete application papers in accordance with the preceding section have been filed with the College of Commerce, the College shall take the matter up for consideration, and if no objection in accordance with this statute shall prevent it, letters patent shall be issued on the invention announced. In the letters patent shall be embodied, the applicant's application in its chief contents; the description given, with reference made to drawings and models, if such
7967 have been furnished; the time for which the patent is granted; the right which is imparted through the patent; and the rules which the patent owner has to comply with in order to come into enjoyment of the patent-right;—it should also be stated in the Letters Patent that it does not imply a certainty that the invention is new or can be profitably applied.

Sec. 8.

If two or more parties file applications for obtaining
7968 of patent on invention of the same kind, the one is entitled to the patent who first shall have filed complete application papers with the College of Commerce.

Sec. 9.

When letters patent are ready to be issued to appli-

7969

plicant, such fact shall be announced by its being posted in the ante-room of the College of Commerce. The day when such posting is made is the date of the letters patent, and the time for the practising of the patent shall be counted from that day.

Sec. 10.

It is the duty of the party to whom patent has been granted:

7970

1st. Publicly to advertise the Letters Patent by inserting the same to its whole contents three times in the "Post och Inrikes Tidningar" (Post and Interior Gazette); and such advertisement shall be effected within two months from the day when the Letters Patent have been posted for issue.

2d. Within two years from the last mentioned day to prove before the College of Commerce that he is in full practice of the invention patented; this term may, 7971
however, be limited by the college at the time of the granting of the patent to one year, and also, on the strength of an application made to that effect, be extended to, at the most, four years, as the nature and extent of the invention may occasion.

3d. Afterwards, each year during the whole patent time, in like manner to prove that the invention is still being practiced.

Sec. 11.

If patent owner wishes to transfer his patent to an- 7972
other party, he must file an announcement with the College of Commerce, which shall pass the resolution to that effect; the new patent owner should therein be reminded of the obligations he has to observe in order to retain the patent right. If the transfer is made to anybody not a resident of the kingdom, it is incumbent upon him to procure an attorney in the

7973 manner directed by Section 6, last paragraph.

Sec. 12.

If patent has been obtained on invention of a nature similar to one already previously patented, or practiced by other party in this kingdom; or if the patent owner has given a wrong or to such an extent incomplete description of the manner and means to be employed in the practicing of the invention that a reliable guidance for passing judgment upon the real nature of the
7974 invention cannot be gained; or if the patent owner has wrongfully stated himself to be inventor; or if a patented invention is found to be conductive to danger as regards common safety or public health, or to contain anything contrary to morals; then anybody who considers his right injured by the patent, and the public prosecutor, if the public interest requires it to be done, may institute an action against the patent that has been issued, before a public court in that community where the patent owner, or if he be a non-resident of the King-
7975 dom, his authorized attorney, had his domicile; and it shall be the duty of the court, in case any of the above specified facts are proved to be existing, to declare that the patent shall be cancelled, in which case also a copy of the judgment should be transmitted without delay by the court to the College of Commerce, which, when the judgment has gained legal force, has to proceed further in the manner directed by sec. 16.

Sec. 13.

7976 If patent owner believes that subsequent to granting of patent other party has been unduly practicing the patented invention, the patent owner may commence action against him through summons before the public court to which he belongs. If the patent owner is able to prove that his right has been infringed in the manner mentioned, the party who has thus prejudiced him

shall be fined, the first time, 100 to 200 rix dollars, national currency, and if he be made out doing it more than once, from 200 to 400 rix dollars, same currency, and each time he shall pay the patent owner full damages. Half of the fine shall belong to the patent owner, who alone has to bring action in such cases, and other half to the poor of that parish where the party fined has his residence. 7977

This fine shall, in event of inability of the party fined to pay the fine, be commuted into simple imprisonment, in accordance with the rules by law for such 7978
commutation.

Sec. 14.

If, during the prosecution of an action instituted before a court for infringement of patent-right, it should be established that the invention for which the patent was made out, has been known and practiced in this kingdom before the application for patent was filed with
the College of Commerce, or that the patent owner has 7979
given a wrong and to such an extent incomplete description of the manners and means to be employed in practicing the invention, that reliable guidance for passing judgment on the real nature of the invention cannot be gained, or that the patent owner has wrongfully stated himself to be the inventor—then the defendant shall be free from responsibility.

Sec. 15.

Patent-right is lost and forfeited: 7980

1st. If patent owner has omitted performing anything of what is prescribed in above section 10.

2nd. If, in consequence of an action, as mentioned in section 12 hereinabove, court has declared that the patent should be cancelled.

7973 manner directed by Section 6, last paragraph.

Sec. 12.

If patent has been obtained on invention of a nature similar to one already previously patented, or practiced by other party in this kingdom; or if the patent owner has given a wrong or to such an extent incomplete description of the manner and means to be employed in the practicing of the invention that a reliable guidance for passing judgment upon the real nature of the
7974 invention cannot be gained; or if the patent owner has wrongfully stated himself to be inventor; or if a patented invention is found to be conductive to danger as regards common safety or public health, or to contain anything contrary to morals; then anybody who considers his right injured by the patent, and the public prosecutor, if the public interest requires it to be done, may institute an action against the patent that has been issued, before a public court in that community where the patent owner, or if he be a non-resident of the King-
7975 dom, his authorized attorney, had his domicile; and it shall be the duty of the court, in case any of the above specified facts are proved to be existing, to declare that the patent shall be cancelled, in which case also a copy of the judgment should be transmitted without delay by the court to the College of Commerce, which, when the judgment has gained legal force, has to proceed further in the manner directed by sec. 16.

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shall be fined, the first time, 100 to 200 rix dollars, national currency, and if he be made out doing it more than once, from 200 to 400 rix dollars, same currency, and each time he shall pay the patent owner full damages. Half of the fine shall belong to the patent owner, who alone has to bring action in such cases, and other half to the poor of that parish where the party fined has his residence. 7977

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given a wrong and to such an extent incomplete description of the manners and means to be employed in practicing the invention, that reliable guidance for passing judgment on the real nature of the invention cannot be gained, or that the patent owner has wrongfully stated himself to be the inventor—then the defendant shall be free from responsibility.

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1st. If patent owner has omitted performing anything of what is prescribed in above section 10.

2nd. If, in consequence of an action, as mentioned in section 12 hereinabove, court has declared that the patent should be cancelled.

7981

Sec. 16.

No less in those cases where patent right has been lost and forfeited, than when the time for which the patent has been granted has expired, it is the duty of the College of Commerce to announce in the "Post och Inrikes Tidningar" (Post and Interior Gazette), that the patent has ceased as to power and effect.

Sec. 17.

7982 Wherever in this our gracious decree a term of months has been prescribed within which certain duties shall be peformed, in applying this rule each month shall be counted at thirty days.

Sec. 18.

This gracious decree shall take effect the 1st of October next, at which time the statutes covering this matter now in force, viz.: The royal decree of Dec. 13th, 1834, and the royal proclamation of Dec. 30,
7983 1841, shall case as to power and effect, without disturbing, however, the legal force given to patents already granted; and it should be observed that complaint which may have been filed with the College of Commerce at the time when this decree takes effect, shall be tried and settled in the manner prescribed by the statutes in force up to the present time.

What all concerned have to obediently follow:

In further testimony whereof, we have subscribed this with our hand and caused it
7984 to be corroborated with our royal seal.

Stockholm Castle, August 19th, 1856.

OSCAR. [L. S.]

7985

Defendant's Exhibit Translation of Edison's Patent. April 30, 1890. S. M., Exr.

UNITED STATES CIRCUIT COURT,

SOUTHERN DISTRICT OF NEW YORK.

The Edison Electric Light Company 7986

vs.

The United States Electric Lighting Company.

In Equity.

No. 3,445.

It is hereby stipulated, for the purposes of this suit, that the papers hereto attached are correct translations of the certified copies of the patent granted to 7987
Thomas A. Edison in Sweden on the 5th day of March, 1880, and of the description accompanying the same and the drawing thereof, as also of the certificates attached to said copies; the said copies of the said patent, specification and drawing being more particularly referred to in the stipulation respecting the same made by the parties hereto on the 24th day of April, 1890.

This stipulation is made for the convenience of the parties and to save time, but is made with the 7988
reservation that the parties may make corrections in the said translations hereafter if any errors shall be found to exist.

April 25, 1890.

Eaton & Lewis,
Solicitors for Complainant.

Duncan, Curtis & Page,
Solicitors for Defendants.

7989

Translation of Swedish Patent of THOMAS A. EDISON of March 5, 1880.

1 Crown Stamp.

7990

1 Crown Stamp.

Cancelled by Seal of Patent

7991 Office.

Charges Kr.		
		2.75
Stamp	"	2.
Total	"	4.75

His Royal Majesty's and National College of Commerce hereby proclaims that Thomas Alva Edison, through the proprietor of the agency-firm, L. A. Groth & Co., Oskar Annell, has applied to said Royal College for patent on an improved construction of electric lamps invented by the first named person for which
7992 purpose there has been delivered to the Royal College a drawing * and also explanation thereof and a description of the invention, as follows:

The object of this invention is, in part, to produce a light-giving body, consisting of a carbon wire or

* This drawing is left in custody of the Register of the Royal College and through him is accessible for those who desire to in spect the same.

7993

sheet, coiled or arranged in such a manner that the greatest possible resistance is offered to the electric current, and at the same time but a slight surface is presented from which radiation can take place;

Further, to place the burner in a nearly perfect vacuum to prevent injury to the burner by the atmosphere.

Further, the method of manufacturing the carbon of high power of resistance, and in the manner of estab-
lishing perfect contact between the metallic conduc- 7994
tors and the carbon.

Heretofore the light has been obtained from a rod of carbon of one to four ohms resistance, kept in a closed globe, from which the atmospheric air has been forced out. The globe, containing the burner, has been composed of glass and by means of cement united to a metallic surface. Connection between the leading wires and the carbon has been effected by clamping screws, etc. The leading wires have always been large,
so that their resistance has been many times less than 7995
the burner, and, in general, the attempts have aimed at a reduction of the resistance in the carbon rod. The disadvantages of this principle are, that the lamps having but one to four ohms resistance cannot be used in multiple without the main conductors being of enormously great dimensions; owing to the low resistance in the lamp the leading wires must be of large dimensions and good conducting power, and a glass globe cannot be made absolutely tight at the place
where the wires pass in; hence the carbon is de- 7996
stroyed, because that requires almost a perfect vacuum in order to possess constant durability, especially when it is small in mass and of high electrical resistance.

I have abandoned this principle, because I have found, in fact, that even a cotton thread, properly carbonized and placed in a tight glass globe, from which the air has been pumped out to one millionth of an at-

7997 mosphere, offers from one hundred to five hundred ohms resistance to the current, and that it is absolutely stable at very high temperatures.

Further, that if the thread be coiled and carbonized, or if any fibrous vegetable substance which on heating in a closed vessel will leave a carbon residue be coiled, as much as two thousand ohms resistance is obtained, without the presence of a greater radiating surface then three-sixteenths of an inch.

Further, that if such fibrous material be mixed with
7998 a plastic mass of lampblack and tar, its resistance can be made high or low according to the quantity of lampblack used. Small pieces of this mass are rolled out in form of wire, only seven one-thousandths of an inch in diameter, and about one foot in length, and coated with a non-conducting substance and wound up on a bobbin or on a spiral. All these forms are, however, fragile and do not admit of any good and reliable contact. I have found that if platina wires are used and the plastic mass of lampblack and tar be
7999 molded around them, with the intention of carbonizing them, there arises an intimate union of the carbon and the platina, and nearly perfect contact is obtained without the use of clamp screws or the like, whereby the burner and the conducting wires are connected with the carbon and ready to be placed in the vacuum globe. When fibrous material is used, the above-mentioned plastic material is used to protect it against the platina before the carbonizing.

I have carbonized and used cotton and linen thread,
8000 wood splints, paper coiled in various ways, also lampblack, plumbago and carbon in different proportions, mixed with tar and kneaded so that they might be rolled out into wires of various lengths and diameters.

Figure 1 shows the lamp sectionally, a is the carbon spiral and c, c' its thicker ends, formed of the plastic mass; d, d' are the platina wires; h are the screws

connecting the platina wires, inserted into the carbon, 8001
with the leading wires x, x, hermetically buried in the glass bell; e, e are copper wires connected with x, x; m is a tube leading to the air pump, which after exhaustion is hermetically closed.

Fig. 2 shows the plastic mass before being wound into a spiral.

Fig. 3 shows the spiral after carbonization and ready 8002
to be introduced into the globe.

As something new and on which patent is sought for:

1. An electric lamp for producing electric light, consisting of a filament of carbon of high power of resistance.

2. The combination of carbon filaments within a vessel preferably of glass, and through which the lead- 8003
ing wires pass, and from which the air is pumped out:

3. A coiled thin carbon filament arranged in such a manner that only a portion of the surface of such a conductor radiates light;

4. The method of joining the platina contact-wires with the carbon filament, and carbonizing of the whole in a closed vessel; all substantially as here shown and described.

In consequence of this application and on the strength of the Royal Decree concerning patents of 8004
August 19th, 1856, the Royal College has deemed proper hereby to grant to Thomas Alva Edison patent for a period of fourteen (14) years on improvements in the construction of electric lamps as set forth by the above mentioned drawing and the above inserted ex-

8005
planation and description; so that the applicant during said period may have the right, to the exclusion of others, alone or through others, everywhere within the Kingdom, to practice the said invention; wherein the applicant must be guided by what the laws and ordinances, now in force, require in regard to the manufacturing and selling of goods.

It is obligatory on the owner of the patent at the risk of the loss of his patent right.

8006

1st, to have these letters patent publicly advertised by inserting the same to their full contents three times in the "Post och Inrikes Tidningar" within two (2) months from this date, each month reckoned as thirty (30) days;

2nd, to prove before the Royal College within two (2) years hereafter; not only that he is in full practice
8007 of the invention now patented, but also that such practice takes place within the Kingdom; and

3rd, to prove in a similar manner every year during the whole period of the patent that the invention is being constantly practiced within the Kingdom.

Should the patent-owner desire to transfer his patent to some other party, then he is required to file notice thereof with the Royal College; and in case such transfer is made to a person residing outside of the Kingdom, shall give to some person domiciled in Sweden, whose name and domicile shall be announced to
8008 the Royal College to be entered on its Register, written authority to speak and answer on behalf of the owner of the patent in all matters pertaining to the patent.

Finally, the Royal College has desired hereby to make known, that these letters patent may not be con-

8009
sidered as guaranteeing certainty as to the novelty of the invention or that it can be used to advantage.

Stockholm, the 5th day of March, 1880.

C. T. af Strom. C. Fr. Waern.
S. L. Stenberg. J. U. Gronlund.
(Seal) G. Hegardt.
L. S.

Copy verified. Ex-officio. C. Aug. Titz.

8010

Seal
Royal Patent
Bureau,
Stockholm.

Wilhelm Swalin.

8011

United States Consulate at Stockholm, Sweden.

I, Nere A. Elfwing, Consul of the United States of America at Stockholm, do hereby certify that the signature of Wilhelm Swalin is his true and genuine signature, and that he is an officer of the Royal Swedish Patent office.

Witness my hand and official seal this 21st day of December, 1889. 8012

NERE A. ELFWING,
U. S. Consul.

[SEAL]
United States
Consulate
Stockholm.

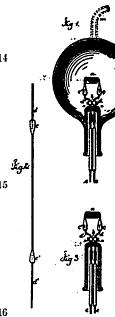
8013

DRAWING OF EDISON'S SWEDISH PATENT,

March 5, 1880.

Royal Patent Bureau, Stockholm.

8014



1 Crown Stamp
Royal Patent
Bureau,
Stockholm.

8015

8016

It is hereby certified that the accompanying drawing is a fac simile of the drawing filed by T. A Edison in 1880 with the Royal College of Commerce and now and henceforth in the custody of the Royal Patent Bureau, in consequence of which patent was granted to Edison

on Electric Lamps under date of the 5th of March, 1880. 8017

STOCKHOLM, Royal Patent Bureau, February 4, 1890.

Ex: Officio,

WILHELM SWALIN.

{ Royal Patent Bureau, Stockholm. }

{ Seal, Royal Patent Bureau, Stockholm. }

Charges Kr.	1.50
Stamp	1.
Total	2.50

8018

United States Consulate
at Stockholm, Sweden. 8019

I, NERE A. ELFWING, Consul of the United States of America at Stockholm, do hereby certify that the signature of Wilhelm Swalin is his true and genuine signature, and that he is an officer of the Royal Swedish Patent Office, whose certificate is entitled to full faith and credit.

Witness my hand and official seal this 5th day of February, 1890. 8020

NERE A. ELFWING,
U. S. Consul.

Seal
United States
Consulate.
Stockholm.

8021

COMMISSION.

The President of the United States of America, to Charles R. Pope, Consul of the United States of America, and C. A. Hirschfalder, Vice-Consul of the United States of America, at Toronto, in the Dominion of Canada, Greeting:

Know ye, That we in confidence of your prudence and fidelity, have appointed you Commissioners, and
8022 by these presents, do give you, and each of you, full power and authority, diligently to examine upon their corporal oaths, or affirmations, before you to be taken, and upon the interrogatories and cross-interrogatories, hereunto annexed, Z. A. Lash and Charles Moss, both of Toronto, in the said Dominion of Canada, as witnesses on the part of the defendant in a certain cause now pending undetermined in the Circuit Court of the United States of America for the Southern District of
8023 New York, wherein the Edison Electric Light Company is the complainant, and the United States Electric Lighting Company is the defendant; the same being a suit in equity and numbered 3445 on the docket of said court.

And we do further empower you, and each of you, to examine on the same behalf, and in like manner, any other person or persons who may be produced as witnesses before you; and we do hereby require you, and each of you, before whom such testimony may be taken, to reduce the same to writing, and to close it up under
8024 your hand and seal directed to John A. Shields, Clerk of the Circuit Court of the United States for the Southern District of New York, at the City of New York, as soon as may be convenient after the execution of this commission; and that you return the same when executed, as above directed, with the title of the cause endorsed on the envelope of the commission.

Witness the Hon. Melville W. Fuller, Chief Justice

of the Supreme Court of the United States, at the City 8025
of New York, this 22d day of April, in the year of our Lord one thousand eight hundred and ninety, and of our Independence the one hundred and fourteenth.

(Signed),

JOHN A. SHIELDS,

Clerk of the Circuit Court of the United States for the Southern District of New York. 8026

[SEAL.]

It is stipulated that a commission may issue as above upon the interrogatories and cross-interrogatories hereto annexed, without further formalities.

April 22, 1890.

C. A. SEWARD,

of Counsel for Complainant. 8027

S. A. DUNCAN,

of Counsel for Defendant.

8028

8029 UNITED STATES CIRCUIT COURT,

SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT CO.,

vs.

THE UNITED STATES ELECTRIC LIGHTING COMPANY.

8030

In Equity, No. 3445.

Interrogatories by Counsel for Defendant, to be propounded to Z. A. Lash, a witness in behalf of the defendant.

Interrogatory 1. What is your name, age, residence and occupation?

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Interrogatory 2. What is the nature and extent of your acquaintance, practically and theoretically, with the laws of the Dominion of Canada and especially with the laws of said Dominion relating to patents for inventions?

Interrogatory 3. Please examine the document certified by A. J. Cambie, as Acting Deputy Commissioner of Patents of the Dominion of Canada, under
8032 the seal of the Patent Office of the Department of Agriculture of the Dominion of Canada, and under date of January 13, 1885, to be a true copy of patent No. 10,654, granted by the Dominion of Canada on November 17, 1879, to Thomas Alva Edison for the period of five years; which document has been introduced in evidence in this cause and marked "Defendant's Ex-

8033
hibit No. 1, Edison's Canadian Patent"; and state under what law the said Canadian patent was issued?

Interrogatory 4. What were the provisions of the law of patents in force in the Dominion of Canada on November 17, 1879, relating to the duration of the Canadian patent where a patent for the same invention exists in a foreign country; and especially in a case where the foreign patent bears date subsequent to the date of the Canadian patent? Quote the parts of the Statutes relating thereto. 8034

Interrogatory 5. What changes, if any, in re ard to the matter inquired of in the last interrogatory have been made in the laws of Canada since the issue of the said Edison patent No. 10,654; and when were such changes made? Quote the parts of the Statutes, if any, containing such changes.

Interrogatory 6. What were the provisions of the laws of Canada in force on November 17th, 1879, in re- 8035
gard to the period for which a patent might be issued, and in regard to the extension of a patent beyond the period for which originally it was issued? Quote the parts of the Statutes relating thereto.

Interrogatory 7. What changes, if any, in regard to the matter inquired of in the last interrogatory have been made in the laws of Canada since the issue of said Edison patent No. 10,654; and when were such changes made? Quote the parts of the Statutes, if 8036
any, containing such changes.

Interrogatory 8. Assume that a patent was granted in the Kingdom of Sweden on the 5th day of March, A, D., 1880, to the Thomas Alva Edison who was the patentee of the Canadian patent No. 10,654 in evidence herein as "Defendant's Exhibit No. 1, Edison's Canadian

8037

Patent", for the same invention as is patented in the said Canadian patent; and assume, further, that the said Swedish patent-right was lost or forfeited at a date prior to the passage of the Canadian Act of May 25, 1883, entitled "An Act to Amend the Patent Act of 1872"; what was the effect upon the said Canadian patent of such loss or forfeiture of the said Swedish patent-right?

Interrogatory 9. Please examine the certificate at-
8038 tached to "Defendant's Exhibit No. 1, Edison's Canadian Patent", No. 10,654, which certificate is signed by J. H. Pope, Commissioner of Patents under date of October 30, 1883, and certifies to the payment to the Commissioner of Patents, on the 4th day of May, 1883, by the holder of the said Edison patent of the sum of forty dollars as being the fee required for the further "term of ten years, to commence and be computed on "and from the 17th day of November, 1884, as provided "by Section 17 of the Patent Act of 1872, amended by
8039 "the Act of 1883".

Assuming that the holder of the said Edison Canadian patent actually paid the forty dollars cited in the said certificate and on the day therein named, and assuming, further, that the said Canadian patent had expired prior to the making of the said payment; what effect under the Statute, if any, did such payment and the making by the Commissioner of Patents of the said certificate of such payment, have upon the said
8040 Canadian patents; and more particularly, what effect, if any, did those acts have by way of extending the said patent?

Interrogatory 10. At what date did the act of the Parliament of the Dominion of Canada, of 46 Victoria, Chap. 19, entitled "An Act to Amend the Patent Act of 1872", go into effect?

8041

Interrogatory 11. In section 17 of the Patent Act of 1872, as amended by chap. 19, 46 Victoria, assented to May 25, 1883, and entitled "An Act to Amend the Patent Act of 1872", occurs the following provision:

> " Every patent heretofore issued by the Pat-
> " ent Office in respect to which the fee required
> " for the whole, or any unexpired portion, of
> " the term of fifteen years, has been duly paid
> " according to the provisions of the now ex-
> " isting law in that behalf, has been and shall 8042
> " be deemed to have been issued for the
> " term of fifteen years, subject, in case a
> " partial fee only has been paid, to cease on
> " the same conditions on which patents here-
> " tofore issued are to cease under the opera-
> " tion of this section."

What effect, if any, did this provision of the Act of 1883 have upon a Canadian patent which had expired
prior to the passage of the said Act? 8043

Interrogatory 12. If, in answer to the last interrogatory, you shall have said that the provision contained in the said Act of 1883, and quoted in the last interrogatory had no effect upon patents which had previously expired, and if it should be shown that the aforesaid Edison Canadian Patent, No 10,654 ("Defendant's Exhibit No. 1, Edison's Canadian Patent"), had expired before the passage of the said Act of 1883,
what, under the laws of Canada, was the term of said 8044
patent?

Interrogatory 13. If the Swedish patent right referred to in Interrogatory 8, had been lost or forfeited on a date subsequent to the 25th of May, 1883, (assuming the last-named date to be the date of the passage of the Act of 46 Victoria, Chap. 19, entitled An Act to Amend the Patent Act of 1872) and if the Edison Canadian Patent No. 10,654 was in force down to such loss

8045
or forfeiture of the said Swedish patent right, what effect had such loss or forfeiture of that patent right upon the said Canadian patent?

Concluding Interrogatory. Do you know, or can you set forth, any other matter or thing which may be of benefit or advantage to the parties at issue in this cause, or either of them, or that may be material to the subject of this, your examination, or the matters at issue in this cause? If yea, set forth the same fully,
8046 and at large in your answer.

DUNCAN, CURTIS & PAGE,
Solicitors for Defendant.

IN THE UNITED STATES CIRCUIT COURT

FOR THE SOUTHERN DISTRICT OF NEW YORK.

8047

THE EDISON ELECTRIC LIGHT CO., Complainant. vs. United States ELECTRIC LIGHTING CO., Defendant.	In Equity. No. 3445.

8048

Cross-interrogatories by counsel for Complainant to be administered to Z.... A. Lash, a witness in behalf of the Defendant.

1 x. If, in answer to any of the direct interrogatories you shall have expressed any opinion as to the construction of the Canadian patent acts, or as to the legal

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effect of any act done under the same, please state whether such opinion has been based upon any decision of any Canadian court, and if so, give a reference to the case, page and volume, in which such decision may be found?

2 x. Has the last paragraph of section 7 of the Canadian act respecting Patents of Invention, assented to June 14, 1872, and commencing with the words, "and under any circumstances" been judicially construed by 8050
a Canadian court, and if so, give a reference to the case, page and volume, in which such decision may be found.

3 x. Were the words "where a foreign patent exists, in said paragraph in your opinion, used by the legislature as referring to a date prior to or contemporaneous with the application for the Canadian patent, or as referring to the issuance of a patent in a foreign country, at any time after the Canadian patent had been fully 8051
issued and delivered? Please refer to any judicial decision by a Canadian court bearing upon this question.

4 x. Is it your opinion that if a Canadian patent were issued on the 1st of January, 1884, under the Canadian patent acts of 1872 and 1883, for the term of 15 years and duly kept alive and thereafter and on the 1st of January, 1885, a patent were issued in Sweden for the same invention to the same inventor for the term of 15 years, and the Swedish patent right were thereafter lost and forfeited by reason of a failure to manufacture 8052
the invention in Sweden and by reason of a failure to report the fact of such manufacture to the proper Swedish authorities according to the Swedish patent law, such loss and forfeiture would terminate the previous Canadian patent.

5 x. If you answer the last question by an affirmative opinion, state whether such loss and forfeiture

8053 would *ipso facto*, terminate the previous patent, or whether such termination would require a judicial procedure to enforce it.

6 x. If you answer cross-question 4 by an affirmative opinion, please state any reason which occurs to you, either in law or in ethics, why a previous Canadian valid patent should be terminated by the loss or forfeiture of a subsequent foreign patent right for a
8054 breach of a condition subsequent under the foreign law.

7 x. Was there not a act respecting patent Inventions in Canada passed by its Legislature in 1886, Chapter 61, which was authorized to be cited as "The Patent Act"?

8 x. Is not such last named Act now in force?

9 x. What was the effect upon the Canadian Patent
8055 Acts of 1872 and 1883 of the passage of the Act of 1886? Are all three of the Acts now in force, or how otherwise?

10 x. Does or does not section 8 of the Act of 1886 take the place of section 7 of the Act of 1872?

11 x. Do or do not the provisions of section 8 modify or change the provisions of section 7, and if yea, in what manner and to what extent?

8056 12 x. Do you read and understand the Swedish language?

13 x. Have you read and do you understand the patent law of Sweden in force on the 5th of March 1880?

14 x. Do you know what effect is given in Sweden by the courts of that country to a patent there granted

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on account of neglect to manufacture the invention within that kingdom and to report the fact of such manufacture to the proper authorities within a prescribed period? If you answer in the affirmative give the sources of your information fully and particularly.

15 x. Have you prior to your becoming a witness herein had any professional connection in any way with either of the parties to the suit in the annexed Commissioner named, and if so, which one of them? 8058

New York City, April 22, 1890.

EATON & LEWIS,
Solicitors for Complainant.

UNITED STATES CIRCUIT COURT. 8059

SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT COMPANY vs. THE UNITED STATES ELECTRIC LIGHTING COMPANY.	In Equity. No. 3445.

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Depositions of witnesses produced, sworn and examined the 26th day of April in the year one thousand eight hundred and ninety, at the City of Toronto, Province of Ontario, Canada, under and by virtue of a commission issued out of the Circuit Court of the

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United States for the Southern District of New York in a certain cause therein depending and at issue wherein The Edison Electric Light Company are plaintiffs, and the United States Electric Lighting Company are defendants, as follows :

Zebulun Aiton Lash of the said City of Toronto, aged forty-three years and upwards, being duly and publicly sworn pursuant to the directions hereto annexed and examined on the part of the defendants doth depose
8062 and say as follows :

1. To the First Interrogatory he saith :—

My name is Zebulun Aiton Lash ; my age is forty-three ; my residence is at the City of Toronto, Ontario, and my occupation is a barrister-at-law and solicitor.

2. To the Second Interrogatory he saith :—

I was called to the bar of Ontario and admitted as a solicitor in the courts there in May, 1868, and since
8063 that time I have been continuously in the active practice of my profession as barrister and solicitor, with the exception of a period of about six years from 1876 till 1882, when I occupied the position of Deputy of the Minister of Justice of Canada, Ottawa. During my active practice, and also during my occupancy of the office referred to, I was continuously engaged in matters relating to the laws of the Dominion of Canada, more particularly to that portion of the Dominion forming the Province of Ontario. During my occu-
8064 pancy of the office referred to, I was constantly called upon to construe the statutory laws of the Dominion, and to advise various departments of the government thereon, including the Department of Agriculture, to which the Patent Office of the Dominion is attached, and including the laws of the Dominion relating to patents for inventions. I have also been engaged in various cases relating to patents for invention and to the laws of the Dominion with respect thereto.

3. To the Third Interrogatory he saith :— 8065

I have examined the document referred to, and I state that the said document, being Defendant's Exhibit No. 1, Edison's Canadian Patent, was issued under the provisions of Chapter 26 of the Statutes of the Dominion of Canada, 35 Vic., A. D. 1872, known as the Patent Act of 1872.

4. To the Fourth Interrogatory he saith :

The provisions of the law of patents in force in the
Dominion of Canada on November 17th, 1879, referred 8066
to in this interrogatory, were those of section 7 of the said, The Patent Act of 1872. The words of that section are as follows :

" But an inventor shall not be entitled to a patent
" for his invention, if a patent therefor in any other
" country shall have been in existence in such country
" more than twelve months prior to the application for
" such patent in Canada; and if during such twelve
" months any person shall have commenced to manu- 8067
" facture in Canada the article for which such patent
" is afterwards obtained, such person shall continue to
" have the right to manufacture and sell such article,
" notwithstanding such patent; and under any circum-
" stances, where a foreign patent exists, the Canadian
" patent shall expire at the earliest date at which any
" foreign patent for the same invention expires.

5. To the Fifth Interrogatory he saith :—

The provisions of the section referred to in the an- 8028
swer to the last interrogatory were not changed until the coming into force of the Revised Statutes of Canada, which came into force on, from, and after the 1st day of March, 1887. In the Revised Statutes referred to is contained chapter 61 entitled an Act respecting Patents of Invention and known as The Patent Act. Section 8 of that Act takes the place of Section 7 of

8069 The Patent Act of 1872, and, there is some difference in the wording of the two sections. By Chapter 4 of 49 Vic., A. D. 1886, entitled An act respecting the Revised Statutes of Canada, is provided in Section 8 thereof that "The said Revised Statutes shall not be "held to operate as new laws, but shall be construed and "have effect as a consolidation and as declaratory of "the law as contained in the said Acts and parts of "Acts so repealed, and for which the said Revised
8070 "Statutes are substituted:

"2. But if upon any point the provisions of the said "Revised Statutes are not in effect the same as those "of the repealed Acts and parts of Acts for which they "are substituted, then, as respects all transactions, "matters and things subsequent to the time when the "said Revised Statutes take effect, the provisions contained in them shall prevail, but, as respects all transactions, matters and things anterior to the said time, "the provisions of the said repealed acts and parts of
8071 "acts shall prevail."

When the Revised Statutes came into force and took effect the Patent Act of 1872, including Section 7 thereof, was repealed, subject, however, to the qualifications in section 8 above quoted. Since the coming into effect of the Revised Statutes referred to, no further changes in regard to the matter inquired of in the last interrogatory have been made in the laws of Canada.

6. To the Sixth Interrogatory he saith:

8072 The provisions referred to in this interrogatory were Section 7 of the Patent Act of 1872 and Section 17 of that act. I have already quoted the provisions of section 7. The provisions of section 17 are as follows:

"Patents of invention issued by the Patent Office "shall be valid for a period of five, ten or fifteen years "at the option of the applicant; but at or before the "expiration of the said five or ten years, the holder "thereof may obtain an extension of the patent for

"another period of five years, and after those second "five years, may again obtain a further extension for "another period of five years, not in any case to exceed a total period of fifteen years in all, and the instrument delivered by the Patent Office for such extension of time shall be in the form which may be from "time to time adopted, to be attached, with reference, "to the patent, and under the signature of the Commissioner, or of any other member of the Privy Council in case of absence of the Commissioner." 8073

7. To the Seventh Interrogatory he saith: 8074

On the 25th day of May, 1883, the Patent Act of 1872 was amended by chapter 19 of the Statutes 46 Vic., A. D. 1883, and by the last-mentioned act section 17 of the Patent Act of 1872 was repealed and the following was substituted therefor:

"1. Section 17 of the 'Patent Act of 1872' is hereby "repealed, and the following is substituted therefor:

"17. The term limited for the duration of every patent of invention issued by the Patent Office shall be 8075
"fifteen years; but at the time of the application therefor it shall be at the option of the applicant to pay "the full fee required for the term of fifteen years, or "the partial fee required for the term of five years, or "the partial fee required for the term of ten years. In "case a partial fee only is paid the proportion of the "fee paid shall be stated in the patent, and the patent shall, notwithstanding anything therein or in "this act contained, cease at the end of the term "for which the partial fee has been paid, unless 8076
"at or before the expiration of the said "term the holder of the patent pays the "fee required for the further term of five or "ten years, and takes out from the Patent Office a certificate of such payment (in the form which may be, "from time to time adopted), to be attached to and to "refer to the patent, and under the signature of the

8077 "Commissioner, or, in case of his absence, another "member of the Privy Council; and in case such "second payment, together with the first payment, "makes up only the fee required for ten years, then "the patent shall, notwithstanding anything therein or "in this Act contained, cease at the end of the term "of ten years, unless at or before the expiration of "such term the holder thereof pays the further fee re-"quired for the remaining five years, making up the "full term of fifteen years, and takes out a like certi-
8078 "ficate in respect thereof. Every patent heretofore is-"sued by the Patent Office in respect of which the fee "required for the whole or for any unexpired portion "of the term of fifteen years, has been duly paid ac-"cording to the provisions of the now existing law in "that behalf, has been and shall be deemed to have "been issued for the term of fifteen years, subject, in "case a partial fee only has been paid, to cease on the "same conditions on which patents hereafter issued "are to cease under the operation of this section."

8079 The provisions of the Section just quoted remained in force until the taking effect or coming into force of the Revised Statutes of Canada above mentioned. Section 22 of the Patent Act contained in those Revised Statutes and above mentioned took the place of the section last quoted. There is some difference in the language of the two Sections and I therefore quote in full the said Section 22:

"The term limited for the duration of every patent
8080 "of invention issued by the Patent Office shall be "fifteen years; but at the time of the application "therefor it shall be at the option of the applicant to "pay the full fee required for the term of fifteen years, "or the partial fee required for the term of five years, "or the partial fee required for the term of ten "years.

"2. If a partial fee only be paid, the proportion of the

8081 "fee paid shall be stated in the patent, and the patent "shall, notwithstanding anything therein or in this Act "contained, cease at the end of the term for which the "partial fee has been paid, unless at or before the "expiration of the said term the holder of the patent "pays the fee required for the further term of five or "ten years, and obtains from the Patent Office a cer-"tificate of such payment in the form which is from "time to time adopted, which certificate shall be at-
"tached to and refer to the patent, and shall be under 8082
"the signature of the commissioner, or the signature "of any other member of the Queen's Privy Council for Canada acting for him:

"3. If such second payment, together with the first "payment, makes up only the fee required for ten "years, then the patent shall, notwithstanding any-"thing therein or in this Act contained, cease at the "end of the term of ten years, unless at or before the
"expiration of such term the holder thereof pays th 8083
"further fee required for the remaining five years, "making up the full term of fifteen years, and obtains "a like certificate in respect thereof."

No further changes on this subject have been made.

8. To the Eighth Interrogatory he saith:

In the case referred to in this Interrogatory the effect upon the said Canadian Patent Number 10,654 of the loss or forfeiture of the said Swedish Patent was
that the said Canadian Patent expired at the date when 8084
the said Swedish Patent was lost or forfeited if such Canadian Patent had not previously expired on account of the earlier loss or forfeiture or expiration of some other foreign patent for the same invention. This effect took place under the provisions of Section 7 of the Patent Act of 1872. When the Swedish Patent was lost or forfeited as referred to in this Interrogatory, it expired within the meaning of the said Section

8085 7, and, consequently, the Canadian Patent also expired at the same time.

9. To the Ninth Interrogatory he saith :

I have examined the certificate referred to in this Interrogatory, and, assuming the facts which I am asked to assume by the Interrogatory, I say that such payment and the making by the Commissioner of Patents of the said certificate had no effect upon the said
8086 Canadian Patent Number 10,654, and that such payment and certificate did not have any effect on said Patent by way of extending the same. The concluding provision of Section 17 of the Patent Act of 1872 as amended or substituted by Chapter 19, 46 Vic., 1883, above quoted applied only to patents issued before the passing of the Act last mentioned which were in force or had not expired at the time of the passing and coming into effect of that Act, viz., on the 25th day of May, 1883. The effect of this Act was not to revive
8087 any previously expired Patent.

10. To the tenth Interrogatory he saith :

The act referred to in this interrogatory went into effect on the day upon which it was assented to, viz., the 25th day of May, 1883.

11. To the Eleventh Interrogatory he saith :

I call attention to a mistake in the quotation in this interrogatory of the provision referred to. The word,
8088 "heretofore" used in the last line but one of the quotation should be "hereafter," as by reference to the Section as quoted by me in answer to a previous interrogatory will appear. This provision of the Act of 1883 had no effect upon a Canadian Patent which had expired prior to the passage of the said Act.

12. To the Twelfth Interrogatory he saith :

If the said Canadian Patent Number 10,654 had ex-

pired before the passage of the said Act of 1883, the 8089
maximum term of said patent under the laws of Canada was five years from the date of said patent, viz., the 17th of November, 1879, with a limitation of such maximum term to such shorter period as might be represented by the earliest date at which any foreign patent for the same invention might expire, should such date be prior to the end of such maximum term.

13. To the Thirteenth Interrogatory he saith : 8090

In the case put in this Interrogatory the said Canadian Patent expired at the date of the expiration of the said Swedish Patent.

14. To the Fourteenth Interrogatory he saith :

It has occurred to me that it may be useful to state the avowed reason for the passing of the Act of 1883 above mentioned. A reason which is well known to those who have followed the course of legislation respecting patents of invention in Canada, and which 8091
was publicly stated by the Minister of the Crown who introduced such Act into Parliament, namely, that under the law as it stood by Section 17 of the Patent Act of 1872, the maximum term of a patent granted under that law for five years was five years, with the right to the patentee to procure an extension of that term for a further term of five or ten years at his option, and that if a patent had been granted in Canada for a term of five years prior to the granting of a patent for the same invention in the United States of America, the United 8092
States Patent under the United States Patent Laws would expire at the end of the five years' term granted by the Canadian Patent. It was to remove this effect that the section referred to was amended and changed. The amendment did not give to the holder of a Canadian Patent, so far as the rights in Canada were concerned, any greater substantial right than he had before.

8093

CROSS INTERROGATORIES.

1. To the First Cross Interrogatory he saith :

The opinions which I have expressed in answer to the direct interrogatories have not been based upon decision of any Canadian Court directly deciding the points upon which the opinions have been expressed. Such opinions have been expressed with general reference to the decisions of Canadian Courts and of the
8094 Courts in England, whose decisions are binding upon the Canadian Courts respecting the construction of statutes, and bearing upon the matters upon which the opinions have been expressed.

2. To the Second Cross Interrogatory he saith :

I am not aware that the paragraph referred to in this cross interrogatory has been judicially construed by any Canadian Court.

8095 3; To the Third Cross Interrogatory he saith :

These words, in my opinion, were used by the Legislature as referring to any foreign patent not in existence more than twelve months prior to the application for the Canadian Patent whether such patent bore date prior to, or contemporaneously with, or subsequently to, the application for the Canadian Patent. Although the words, "where a foreign patent exists," are in the present tense, yet, in my opinion, taken in connection with the construction of the whole
8096 Section and the policy of the whole Act, and giving effect to each part of the provision itself, such words apply to the circumstances as they arise and refer to a foreign patent which did not exist at the time of the application for or granting of the Canadian Patent. Section 6 of Chapter 1 of the Statutes of Canada passed in the year 1867, 31 Vic., entitled "An Act respecting the Statutes of Canada," and known as

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the Interpretation Act, provides as follows :

"In construing any Act of the Parliament of Canada "unless it is otherwise provided, or there be some- "thing in the context or other provision thereof indica- "ting a different meaning or calling for a different "construction,

* * * * * *

"(2.) The law is to be considered as always speaking "and whenever any matter or thing is expressed in the 8098
"present tense the same is to be applied to the circum- "stances as they arise, so that effect may be given to "each Act and every part thereof according to its "spirit, true intent and meaning."

This Interpretation Act was in force at the time of the passing of the Patent Act of 1872, and remained in force down to the coming into effect of the Revised Statutes of Canada. In the Revised Statutes is contained an Interpretation Act of like import.

In my opinion the context of Section 7 of 8099
the Patent Act of 1872 does not require any construction which would interfere with the provisions of Sub-section 2 of Section 6 of the said Interpretation Act, but, on the contrary, I think that the provisions of this Sub-section are applicable. I do not wish, however, to be understood as construing Section 7 of the Patent Act of 1872 in the way I have construed it merely because of the existence of the provisions of the Interpretation Act mentioned. I am not aware of any judicial decision by a Canadian Court bearing directly upon the question referred to in this cross-interrogatory. 8100

4. To the Fourth Cross-Interrogatory he saith :—

I am not sufficiently familiar with the Swedish law to know whether the reason of failure to manufacture the invention in Sweden, or of failure to report the fact of such manufacture to the proper Swedish authorities affects the nature of the loss and forfeiture of a Swedish

8101 patent. Assuming, however, that the Swedish patent were lost and forfeited according to the ordinary English construction of those words, I am of opinion that if the Swedish patent referred to in this interrogatory were lost and forfeited, the Canadian patent referred to would expire at the date at which such Swedish patent was lost and forfeited. I have previously expressed the opinion that the loss and forfeiture referred to would be an expiry of the Swedish patent within the meaning of Section 7 of the Patent Act of 1872.

8102 5. To the Fifth Cross-Interrogatory he saith :—

The previous patent would expire by reason of the existence of the fact which under the statute would cause it to expire. No judicial procedure to declare the expiry would be required if the question means whether such judicial procedure is a necessary ingredient in, or condition precedent to, the expiration.

6. To the Sixth Cross-Interrogatory he saith :—

8103 It is not possible in a subject of this nature for a statute to embody any precise principle or theory which would run through the whole of the provisions of such a statute and be logically consistent throughout. The policy of Parliament in such matters must necessarily be roughly and broadly framed. The general intention of Section 7 of the Patent Act of 1872 no doubt was that Canadian manufacturers should not be fettered while foreign manufacturers remained free. This intention would be better served by the construction which would
8104 cause the Canadian patent to expire when any foreign patent for the same invention expired, whether such foreign patent were granted before or after the granting of the Canadian patent, rather than by the construction which would limit the foreign patent referred to to the one case of a foreign patent granted prior to the granting of the Canadian patent. I am aware that if the principle involved in this policy were logically carried

out the proper provision would be to refuse to an applicant for a Canadian patent any grant of a monopoly 8105
until he had procured patents in every foreign country, but such a provision would be impracticable. On this question it may be useful to refer to the case of in re Blake's Patent, reported in volume 4, English Law Reports, Privy Council Appeals, page 535, where their Lordships of the Privy Council, speaking through Sir Barnes Peacock use the following language: "It has "been stated in argument that there is not much dif-
"ference between allowing a foreign patent to expire 8106
"and not taking out a foreign patent at all. There is "this difference, that where a patentee takes out a "patent for a foreign invention he is taking active "measures to make the invention known in the coun-"try in which he takes out such patent, and the Leg-"islature has not said that no patent shall be grant-"ed in England for a foreign invention unless the in-"ventor shall have taken out a patent in some other "country. If they had so provided it would, in effect,
"be prohibiting altogether a grant of a patent for 8107
"a foreign invention. The Legislature has not "declared such to be their policy upon that subject, "but they have declared that where a foreign inventor "has taken out a patent in England for such invention "and has also taken out a patent in a foreign country, "and has allowed such foreign patent to expire, then, "as Lord Hatherly stated in the case of Daw. v. Eley, "it is apparent that the object of the Legislature was "to prevent the English manufacturer from being fet-
"tered while the foreigner remained free." 8108

7. To the Seventh Cross-Interrogatory he saith :

There was. It is Chapter 61 of the Revised Statutes of Canada to which I have referred in my answer to one of the interrogatories-in-chief. It is not strictly accurate to say that this Chapter was passed in 1886.

8109
The Act respecting the Revised Statutes of Canada was
passed in 1886, but the Statutes themselves did not come
into force until a proclamation was issued under the
Act last mentioned by which proclamation they were
brought into force on the 1st of March, 1887.

8. To the Eighth Cross-Interrogatory he saith:

Yes. Chapter 61 referred to is now in force. There
was a slight amendment to it made during the present
8110 session of the Dominion Parliament, but in no way af-
fecting the questions involved in these interrogatories
and cross-interrogatories.

9. To the Ninth Cross-Interrogatory he saith:

By the Act of 1826 referred to in this Cross-Interrog-
atory I assume is meant Chapter 61 of the Revised
Statutes of Canada. By Chapter 4 of 49 Vic., 1886,
entitled an "Act respecting the Revised Statutes of
Canada," the Patent Act of 1872 and the Act of 1883
8111 referred to became repealed on, from, and after the day
that the Revised Statutes came into force and effect.
By Section 7 of the Act last mentioned it is declared
that the repeal of the acts and parts of acts embodied
in the Revised Statutes shall not affect any penalty for-
feiture or liability civil or criminal incurred before the
time of such repeal, and that such repeal shall not de-
feat, disturb, invalidate or prejudicially affect any mat-
ter or thing whatsoever had, done, completed, existing
or pending at the time of such repeal, but every such
8112 penalty, forfeiture and liability matter and thing may
and shall remain and continue as if no such repeal had
taken place. In so far as the provisions of the repealed
acts are in effect the same as those of the Revised Stat-
utes, such repealed acts may be considered as still in
force; and, in so far as they differ from those of the Re-
vised Statutes, they are still in force as respects trans-
actions, matters, and things anterior to the time the

8113
Revised Statutes took effect; and, in so far as they dif-
fer from the provisions of the Revised Statutes, the
last-mentioned provisions prevail, except as to trans-
actions, matters, and things anterior to their coming
into force.

10. To the Tenth Cross-Interrogatory he saith:

Section 8 of the Act of 1886 takes the place of Sec-
tion 7 of the Act of 1872, subject to the explanations 8114
given in answer to the last cross-interrogatory.

11. To the Eleventh Cross-Interrogatory he saith:

The language of Section 8 differs in some respects
from that of Section 7 referred to, and, in order that
the two sections may be compared, I now quote the
language of Section 8, namely: "No inventor shall be
" entitled to a patent for his invention if a patent
" therefor, in any other country, has been in existence
" in such country for more than twelve months prior to 8115
" the application for such patent in Canada; and if,
" during such twelve months, any person has com-
" menced to manufacture in Canada the invention for
" which such patent is afterwards obtained, such per-
" son shall continue to have the right to manufacture
" and sell such article, notwithstanding such patent;
" and under any circumstances, if a foreign pat-
" ent exists, the Canadian patent shall expire at
" the earliest date at which any foreign patent for
" the same invention expires." 8116

12. To the Twelfth Cross-Interrogatory he saith:

I do not.

13. To the Thirteenth Cross-Interrogatory he saith:

I have read what is stated in the book containing
the same printed in the English language to be the

8117 Patent Law of Sweden, but I have not read the same in its original, and I do not know how far the English book referred to correctly and accurately states the provisions of that law.

14. To the Fourteenth Cross-Interrogatory he saith:

I am not able to express any opinion as to the Swedish law or the effect given by the courts in Sweden to such law.

8118 15. To the Fifteenth Cross-Interrogatory he saith:

I have acted as solicitor for the United States Electric Lighting Company, defendants herein, in defending some proceedings taken by the plaintiffs herein in Ontario for alleged infringement of the plaintiff's patents of invention. Such proceedings went as far as the service of the Statement of Claim only, and were then stayed by order of the Court until security for costs was given. Such order is still in force and no
8119 defence has yet been entered, and the case has not been tried.

I also acted in the interests of the said defendants in connection with certain proceedings before the Minister of Agriculture in Ottawa, between the Royal Electric Co. and the plaintiffs herein.

April 26, 1890.

Z. A. LASH.

Examination taken reduced to writing, and by the witness subscribed and sworn to this
8120 twenty-sixth day of April, A.D., 1890, before

CHARLES R. POPE,

Commissioner and Consul of the United States of America at Toronto, Province of Ontario, Dominion of Canada.

[SEAL.]

8121

DOMINION OF CANADA,
Province of Ontario,
County of York.

I, Charles Roche Pope, United States Consul at the City of Toronto in the said County of York, do certify that Z. A. Lash, the witness, personally appeared before me on the 26th day of April, one thousand eight hundred and ninety, at three o'clock in the afternoon, at my office at the said City of Toronto in the County of York, Province of Ontario and Dominion of Canada, 8122
and after being sworn to testify the truth, the whole truth and nothing but the truth, did depose to the matters contained in the foregoing depositions, and did in my presence subscribe the same. And I further certify that I have subscribed my name to each half sheet thereof and to each exhibit. And I further certify that no person other than the witnesses under the commission hereunto annexed appeared before me.

[SEAL.] CHARLES R. POPE,
United States Consul. 8123

8125 UNITED STATES CIRCUIT COURT.

SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT CO. vs. THE UNITED STATES ELECTRIC LIGHTING COMPANY.	In Equity. No. 3,445.

8126

Interrogatories by counsel for defendant, to be propounded to Charles Moss, a witness in behalf of the defendant.

Interrogatory 1. What is your name, age, residence and occupation?

8127 Interrogatory 2. What is the nature and extent of your acquaintance, theoretical and practical, with the laws of the Dominion of Canada, and particularly with the laws of said country relating to patents for inventions?

Interrogatory 3. Assume that a patent was granted in Canada, under the general law there existing, on November 17, 1879, for the period of five years, and that on the 5th day of March, 1880, the same inven-
8128 tion was patented to the same person in the Kingdom of Sweden; also that the said Swedish patent expired prior to the passage of the Canadian Act of May 25, 1883, entitled "An Act to Amend the Patent Act of 1872"—Chap. 19 of 46 Victoria. What effect did the expiration of the said Swedish patent have upon the said Canadian Patent?

Interrogatory 4. Please examine the certificate at- 8129
tached to the Canadian Patent of Thomas A. Edison, No. 10,654 of November 17, 1879, a copy of which is in evidence in this cause as "Defendant's Exhibit No. 1, Edison's Canadian Patent," which certificate is signed by J. H. Pope, Commissioner of Patents, under date of October 30, 1883, and certifies to the payment to the Commissioner of Patents, on the 4th day of May, 1883, by the holder of the said Edison patent, of
the sum of forty dollars, as "being the fee required for 8130
"the further term of ten years, to commence and be "computed on and from the 17th day of November, "1879, as provided in Section 17 of the Patent Act of "1872, amended by the Act of 1883."

Assuming that the holder of the said Edison Canadian patent actually paid the forty dollars cited in the said certificate, and on the day therein named, and assuming, further, that the said Canadian patent had expired prior to the making of the said payment;
what effect, if any, did such payment and the making 8131
by the Commissioner of Patents of the said certificate of such payment, have upon the said patent; and more particularly, what effect, if any, did those acts have by way of extending the said patent?

Interrogatory 5. In Section 17 of the Patent Act of 1872, as amended by Chap. 19, 46 Victoria, assented to May 25, 1883, and entitled "An Act to Amend the Patent Act of 1872," occurs the following provision:

"Every patent heretofore issued by the Patent Of- 8132
"fice in respect to which the fee required for the "whole, or any unexpired portion, of the term of "fifteen years has been duly paid according to the "provisions of the now existing law in that behalf, has "been and shall be deemed to have been issued for "the term of fifteen years, subject, in case a partial "fee only has been paid, to cease on the same condi-

8133
"tions on which patents heretofore issued are to cease "under the operation of this section."

What effect, if any, did this provision of the Act of 1883 have upon a Canadian patent which had expired prior to the passage of the said Act?

Interrogatory 6. If, in answer to the last interrogatory, you shall have said that the provision contained in the said Act of 1883, and quoted in the last inter-
8134 rogatory had no effect upon patents which had previously expired, and if it should be shown that the aforesaid Edison Canadian patent, No. 10,654 ("Defendant's Exhibit No. 1, Edison's Canadian Patent"), had expired before the passage of the said Act of 1883, what, under the laws of Canada, was the term of said patent?

Interrogatory 7. If the Swedish patent referred to in Interrogatory 3 expired at a date subsequent to the
8135 25th of May, 1883 (assuming the last-named date to be the date of the passage of the Act of 46 Victoria Chap. 19, entitled An Act to Amend the Patent Act of 1872), and if the Edison Canadian Patent No. 10,654 was in force down to the expiration of the said Swedish patent, what effect had the expiration of that patent upon the said Canadian patent?

Concluding Interrogatory. Do you know, or can you set forth, any other matter or thing which may be
8136 of benefit or advantage to the parties at issue in this cause, or either of them, or that may be material to the subject of this your examination, or the matters at issue in this cause? If yea, set forth the same fully and at large in your answer.

DUNCAN, CURTIS & PAGE,

Solicitors for Deft.

8137

IN THE UNITED STATES CIRCUIT COURT

FOR THE SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT COMPANY, Complainant, vs. UNITED STATES ELECTRIC LIGHTING COMPANY, Defendant.	In Equity. No. 3445. 8138

Cross Interrogatories by counsel for Complainant to be administered to Charles Moss, a witness in behalf of the defendant.

Cross Interrogatory 1. If, in answer to the Third 8139
Interrogatory, you undertake to state what effect the expiration of the Swedish Patent would have upon the Canadian Patent, state whether you know of any decision of any Canadian Court which in any way sustains such opinion as you may express. Please cite the case by name, page and volume so that it may be found in New York.

Cross Interrogatory 2. Please quote at length the sections of the Canadian Patent Law which you may examine, or to which you may refer in your answer to 8140
the Fourth Interrogatory, and then state what other or further thing was required to be done under the Canadian Law to secure the extension of a patent by the payment of fees applicable to an extended term thereof.

8141 Cross Interrogatory 3. If, as matter of law, the Canadian Patent referred to in the Fourth Interrogatory had not expired, and the payment was made and the certificate given as specified in said Interrogatory, state whether or not such patent was thereby extended for the length of time for which the $40 under the Canadian statute was applicable.

Cross Interrogatory 4. If you give any opinion, as
8142 requested in the Fifth Interrogatory, state whether there is any decision of the Courts of Canada which support such opinion, and, if so, give a reference to such decision by name, page and volume, so that the same may be found in New York.

Cross Interrogatory 5. If, in answer to the Sixth Interrogatory, you shall have expressed any opinion as to the term of the patent therein inquired about, please state whether there is any decision of any Canadian
8143 Court which sustains your opinion, and, if so, give a reference to the same by case, page and volume so that it can be found in New York.

Cross Interrogatory 6. If you express any opinion in answer to the Seventh Interrogatory, please state whether such opinion is supported by the decision of any Canadian Court, and, if so, please give a reference to such case by name, page and volume, so that the same can be found in New York.

8144 Cross Interrogatory 7. If in answer to any of the Interrogatories you shall have stated that the Canadian patent had expired, or was about to expire, please state whether such expiration occurred *ipso facto* by reason of any, and, if so, what circumstances upon which you have relied, and without any Judicial procedure.

Cross Interrogatory 8. Are you familiar with the 8145
Canadian Patent Act of 1886, entitled "An Act Respecting Patents or Inventions", Chap. 61, and which says that it may be cited as the "Patent Act". Is such Act now in force? If it is, what effect did such Act of 1886, have upon the Canadian Patent Act of 1872, and the Amendatory Act of May, 25th 1883? Are all three of said Acts now in force, and if not how otherwise?

Cross Interrogatory 9. Does section 8 of the Act
of 1886, in your opinion in any respect modify or 8146
change the provisions of Section 7 of the Act of 1872, and, if so, to what extent? Please state fully, and particularly.

Cross Interrogatory 10. Do you read the Swedish language? Do you know the provisions of the Swedish Patent Law which were in force in May, 1883?

Cross Interrogatory 11. Do you know the effect which the Courts of Sweden give to the provisions
of that law, which require the owner of a Swedish 8147
Patent to work the invention within that Kingdom, and to make a report of his so doing to the proper Swedish authorities? If you say you do know such effect, then state how you ascertained the same, and give a reference to any authorities upon which you may rely as evidence of the existence of the fact which you say you know.

New York City, April 22, 1890.

EATON & LEWIS, 8148
Solicitors for Complainant.

8149

CHARLES MOSS, of the said City of Toronto, Barrister-at-Law, aged fifty years and upwards, being duly and publicly sworn pursuant to the directions hereto annexed and examined on the part of the defendants, doth depose and say, as follows:

1. To the First Interrogatory he saith:

Charles Moss; aged 50; residence, Toronto; occupation, Barrister-at-Law and Solicitor of the High
8150 Court of Justice of Ontario.

2. To the Second Interrogatory he saith:

I have been engaged in the active practice of my profession in the Courts of the Dominion of Canada and especially of the Province of Ontario for upwards of twenty years, and during that time I have had occasion to make myself acquainted, both theoretically and practically, with the greater number of the laws of the Dominion, especially those relating to civil
8151 matters; and I have been engaged in a very considerable number of suits and actions in which questions involving the validity of patents of invention have been under consideration or have been in issue.

3. To the Third Interrogatory he saith:

In my opinion, the effect of the expiration of the Swedish Patent upon the said Canadian Patent was that the Canadian Patent also expired upon the date on which the Swedish Patent expired.

8152

4. To the Fourth Interrogatory he saith:

In the circumstances stated in this interrogatory, I am of opinion that the payment and making by the Commissioner of Patents of the certificate of payment referred to had no effect upon the said patent and did not operate to revive it or extend its duration.

5. To the Fifth interrogatory he saith: 8153

I observe that in the provision of the Act, Chapter 19, 46 Vic., as cited in this Interrogatory, a mistake has been made in the use of the word "heretofore" in the last line but one of the said citation. The word in the Act is "hereafter." I am of opinion that this provision had no effect upon the Canadian Patent, which had expired prior to the passing of the act.

8154

6. To the Sixth Interrogatory he saith:

The duration of the term of the patent was five years from the 17th November, 1873, but that term was modified or controlled by the provisions of Section 7 of the Patent Act of 1872, providing in the last part thereof that under any circumstances where a foreign patent exists the Canadian patent shall expire at the earliest date at which any foreign patent for the same invention expires. The maximum term of
the patent, therefore, was subject to be limited by the 8155
determination of any foreign patent at a date prior to the date fixed in the patent in question for the duration of its term.

7. To the Seventh Interrogatory he saith:

The effect of the expiration of the Swedish patent would be to cause the Canadian patent to expire as of the date of the expiration of the Swedish patent.

8156

8. To the Eighth Interrogatory he saith:

I have nothing further to set forth.

8157 CROSS-INTERROGATORIES.

1. To the First Cross-Interrogatory he saith:

I am not aware that the question which is expressly answered here has been judicially considered or determined by a Canadian Court or that any reported case involving a decision by a Canadian Court upon this exact point is to be found. I base my opinion upon the construction of the Statute, having regard to the decisions bearing upon such matters.

8158 2. To the Second Cross-Interrogatory he saith:

The provision which was in force at the time the payment of the forty dollars was made was Section 17 of The Patent Act of 1872, which affected the period for which patents were to be in force, and Section 34, which relates to the fees to be paid for the issue of the patents. The provisions of Section 34, so far as appear to be material are as follows:

"The following fees shall be payable to the Commissioner before an application for any of the pur-
8159 "poses hereinafter mentioned shall be entertained, "that is to say, a petition for a patent for five years, "Twenty dollars; a petition for a patent for ten years, "Forty dollars; a petition for a patent for fifteen years "Sixty dollars; a petition for extension from five to "ten years, Twenty dollars; a petition for extension "from ten to fifteen years, Twenty dollars; a petition "for extension from five to fifteen years, Forty dollars."

Section 17 of the Patent Act of 1872, was subse-
8160 quently repealed by an act passed in the year 1883, 46 Vic., Cap. 19, and this amendment was in force when the certificate in question was granted. Assuming that nothing had occurred to put an end to the patent up to the time when payment was made and that there had been no change in the law prior to the time when the certificate was granted, then the further thing required would have been an instrument of extension in

the form provided for in Section 17 of the Patent 8161
Act of 1872; but, assuming that nothing had occurred to avoid the patent or put an end to it up to the date of the granting of the certificate of the 30th October, 1883, no further or other thing than the payment and the taking out of a certificate thereof was required in order to keep the patent in force.

3. To the Third Cross-Interrogatory he saith:

Assuming that the payment is to be dealt with as applicable under the provisions of the Act of 1883 8162
amending Section 17, of the Patent Act of 1872, and that at the time the certificate of the 30th October, 1883, was granted the Canadian Patent had not expired, the effect of the payment and certificate would be to keep the patent in force for the term for which the Forty dollars was applicable.

4. To the Fourth Cross-Interrogatory he saith:

I am not aware of any reported decision of a case in which the point in question has been considered or 8163
determined upon by the Courts of Canada.

5. & 6. To the Fifth and Sixth Cross-Interrogatories he saith:

I make the same answer to these cross-interrogatories as to the preceding one.

7. To the Seventh Cross-Interrogatory he saith:

The expiration occurred by reason of the occurrence of the circumstances specified in the Statute 8164
with respect to the existence of a foreign patent and the expiration of such foreign patent before the expiration of the term mentioned in the Canadian patent. It is not essential that any judicial proceeding should be instituted or had for the purpose.

8. To the Eighth Cross-Interrogatory he saith:

I am familiar with the Act of 1886, which is a revi-

8165 sion and consolidation of the various enactments with respect to patents that have been made by the Parliament of Canada since the year 1867. This Act is now in force, being Chapter 61 of the Revised Statutes of Canada. Its effects upon the Canadian Patent Act of 1872, and the amendatory Act of May 25th, 1883, is as shown in the Act 49 Vic., Chapter 4 of the Statutes of Canada, passed in the year 1886, known as an Act respecting the Revised Statutes of Canada. By the provisions of that Act, the Canadian Patent Act of
8166 1872, and the amendatory Act of 1883, are repealed from and after the day appointed by proclamation by the Governor-in-Council for the Revised Statutes of Canada to come into force and take effect. The Revised Statutes were by proclamation declared to come into force and have effect as law on, from and after the 1st day of March, 1887. By the 8th Section of the Act of 49 Vic., Cap. 4, the Revised Statutes are not to be held to operate as new laws, but are to be construed and have effect as a consolidation and as
8167 declaratory of the law as contained in the Acts and parts of Acts repealed and for which the Revised Statutes are substituted and, further, that if on any point, the provisions of the Revised Statutes are not in effect the same as those of the repealed Acts and parts of Acts for which they are substituted then as respects all transactions, matters, and things subsequent to the time when the Revised Statutes take effect the provisions contained in them shall prevail, but as respects all transactions,
8168 matters and things anterior to the said time the provisions of the repealed Acts and parts of Acts shall prevail. By Section 7 of the Act of 49 Victoria, Cap. 4 the repeal of the Acts and parts of Acts is not to affect any penalty forfeiture or liability civil or criminal incurred before the time of such repeal, nor shall such repeal defeat, disturb, invalidate, or prejudicially affect any other matter or thing whatsoever had, done, completed, existing or pending at the time of such re-

peal, but every such penalty forfeiture and liability 8169
and matter and thing, (amongst other matters) may and shall remain and continue as if no such repeal had taken place. The three Acts referred to in this Cross-Interrogatory are in force to the extent above explained.

9. To the Ninth Cross-Interrogatory he saith:

Section 8 of the Act of 1886 is not in precisely the same language as Section 7 of the Patent Act of 1872, and it may be that the change of language might be 8170
held to modify or change the construction with reference to matters occurring since the Act of 1886 took effect, though I do not wish to be understood as having formed any decided conviction that such would be the case.

10. To the Tenth Cross-Interrogatory he saith:

I do not read the Swedish Language. My acquaintance with the Swedish patent laws is derived from a perusal of what purports to be the English translations 8171
of them contained in collections of the Patent Laws of the World which I have read, but, otherwise than this, I do not know the provisions of the Swedish Patent Laws.

11. To the Eleventh Cross-Interrogatory he saith:

I do not know the effect which the Courts of Sweden give to the provisions of their law in respect to the matters stated in this Cross-Interrogatory.

CHARLES MOSS. 8172

April 26, 1890.

Examination taken, reduced to writing and by the the witness subscribed and sworn to, this twenty-sixth day of April, A. D., 1890, before

CHARLES R. POPE,
Commissioner and Consul of the United
[SEAL.] States of America, at Toronto, Province
of Ontario, Dominion of Canada.

8165 sion and consolidation of the various enactments with respect to patents that have been made by the Parliament of Canada since the year 1867. This Act is now in force, being Chapter 61 of the Revised Statutes of Canada. Its effects upon the Canadian Patent Act of 1872, and the amendatory Act of May 25th, 1883, is as shown in the Act 49 Vic., Chapter 4 of the Statutes of Canada, passed in the year 1886, known as an Act respecting the Revised Statutes of Canada. By the provisions of that Act, the Canadian Patent Act of
8166 1872, and the amendatory Act of 1883, are repealed from and after the day appointed by proclamation by the Governor-in-Council for the Revised Statutes of Canada to come into force and take effect. The Revised Statutes were by proclamation declared to come into force and have effect as law on, from and after the 1st day of March, 1887. By the 8th Section of the Act of 49 Vic., Cap. 4, the Revised Statutes are not to be held to operate as new laws, but are to be construed and have effect as a consolidation and as
8167 declaratory of the law as contained in the Acts and parts of Acts repealed and for which the Revised Statutes are substituted and, further, that if on any point, the provisions of the Revised Statutes are not in effect the same as those of the repealed Acts and parts of Acts for which they are substituted then as respects all transactions, matters, and things subsequent to the time when the Revised Statutes take effect the provisions contained in them shall prevail, but as respects all transactions,
8168 matters and things anterior to the said time the provisions of the repealed Acts and parts of Acts shall prevail. By Section 7 of the Act of 49 Victoria, Cap. 4 the repeal of the Acts and parts of Acts is not to affect any penalty forfeiture or liability civil or criminal incurred before the time of such repeal, nor shall such repeal defeat, disturb, invalidate, or prejudicially affect any other matter or thing whatsoever had, done, completed, existing or pending at the time of such re-

peal, but every such penalty forfeiture and liability 8169
and matter and thing, (amongst other matters) may and shall remain and continue as if no such repeal had taken place. The three Acts referred to in this Cross-Interrogatory are in force to the extent above explained.

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I do not know the effect which the Courts of Sweden give to the provisions of their law in respect to the matters stated in this Cross-Interrogatory.

CHARLES MOSS.

April 26, 1890. 8172

Examination taken, reduced to writing and by the the witness subscribed and sworn to, this twenty-sixth day of April, A. D., 1890, before

CHARLES R. POPE,
Commissioner and Consul of the United
[SEAL.] States of America, at Toronto, Province
of Ontario, Dominion of Canada.

8173 DOMINION OF CANADA,

PROVINCE OF ONTARIO.

County of York.

I, CHARLES ROCHE POPE, United States Consul at
the City of Toronto in the said County of York, do
Certify that Charles Moss, the witness, personally ap-
peared before me on the 26th day of April, one thou-
8174 sand, eight hundred and ninety, at three o'clock in the
afternoon at my office, at the said City of Toronto in
the County of York, Province of Ontario, and Domin-
ion of Canada, and after being sworn to testify the
truth, the whole truth and nothing but the truth, did
depose to the matters contained in the foregoing de-
positions, and did in my presence subscribe the same.
And I further certify that I have subscribed my name
to each half sheet thereof and to each exhibit. And
I further certify that no person other than the wit-
8175 nesses under the commission hereunto annexed ap-
peared before me.

CHARLES R. POPE,
[SEAL.] United States Consul.

8176

[*Endorsement on foregoing papers as follows:*] 8177

UNITED STATES CIRCUIT COURT,

SOUTHERN DISTRICT OF NEW YORK.

Edison Electric Lighting Co.,
vs.
United States Electric Lighting Co. 8178

Deposited in the Post Office at the City of Toronto, this 28th day of April, 1890, by me.

CHARLES R. POPE. [SEAL.]
Commissioner and United States Consul.

8179
To the Circuit Court of the United States, for the Southern District of New York, at the City of New York.

Care of
JOHN A. SHIELDS,
Clerk.

The execution of the commission appears in certain schedules hereunto annexed.

CHARLES R. POPE. [SEAL.] 8180
Commissioner and United States Consul,
[SEAL.] Province of Ontario, County of York,
Toronto, Dominion of Canada.

Opened and filed by order of Court, this 30th day of April, A. D., 1890.

8181

Stipulation of June 18, 1890, re Edison's Swedish Patent.

CIRCUIT COURT OF THE UNITED STATES,

SOUTHERN DISTRICT OF NEW YORK.

8182 THE EDISON ELECTRIC LIGHT CO.
vs.
THE UNITED STATES ELECTRIC LIGHTING CO.
In Equity. No. 3,445.

It is hereby stipulated that the newspaper, the *Post and Interior Gazette*, hereto annexed is the official gazette of the Kingdom of Sweden referred to in Sec. 3 of the stipulation made by the parties to this suit
8183 April 24, 1890: that (subject to the correction of any inaccuracies that may hereafter be found to exist therein) the translation of the said Gazette, so far as the same relates to the Edison patent of March 5, 1880, a copy of which is in evidence as "Defendent's Exhibit Edison's Swedish Patent," is as follows:

"Post and Interior Gazette is published to-" day, Friday, under No. 45A. and 45B.

8184 "The Royal College of Commerce hereby " publishes for the information of the public " that the following patents issued by the Royal " College have ceased as to all power and " effect, partly in consequence of the expira-" tion of the term of the patents and partly in " consequence of the failure of the patent " owner, in one way or an other, to comply

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" with the conditions for the advantage of " patents prescribed by the Royal Decree in " regard to Patents, of August 19, 1856, to " wit: patent for

* * * * * * *

"73rd. Thomas Alva Edison, of the fifth " March, 1880, on stated Improvements in " the Construction of Electric Lamps.

* * * * * * *

"And the Royal College also wishes to an- 8186
" nounce that the descriptions of the above-" named inventions, and also the drawings, " models and specimens that have been filed " with some of the above descriptions, are " accessible with the register of the Royal " College for those who wish to inspect them.

"Stockholm, 11th of January, 1884.";

that the said Edison patent stands No. 73 in a list of 8187
366 patents included in the said publication, the said publication being designed to include all patents which ceased as to power and effect during the calendar year 1883, whether by reason of the expiration of their terms or of the failure of their owners in any way to comply with the conditions of the patent law; and that the said Edison patent was included in the said list because of the failure of the owner of the same to make proof of the working of the invention 8188
in Sweden during the third year of its term.

C. A. SEWARD,
for Complainants.
SAMUEL A. DUNCAN,
for Defendants.

June 18, 1890.

8189

NEW YORK, June 28, 1890.

Met at 120 Broadway, at the office of Duncan & Page, pursuant to agreement of counsel.

Present—

RICHARD N. DYER, ESQ.,
Of Counsel for Complainant.

SAMUEL A. DUNCAN, ESQ.,
Of Counsel for Defendant.

8190 It is stipulated that defendant's time for taking testimony under the order of the Court dated May 29, 1890, be extended to include Monday, June 30, 1890.

8191 GEORGE W. HEBARD, being called as a witness on behalf of the defendant after first being duly cautioned and sworn, testifies as follows:

1 Q. You are president of the defendant corporation?

A. Yes, sir.

2 Q. State whether you are acquainted with Walter K. Freeman who filed an application for letters patent of the United States for an improvement in electric lamps, July 25, 1881, as set forth in the document which I now show you?

8192 Complainants' counsel objects to all testimony relating to the application referred to, or to any proceedings herein, as not supported by the answer or the pleas of defendant, and as incompetent and irrelevant.

A. Yes, sir, I am.

Defendant's counsel offers in evidence the

8193

document last referred to, the same being a certified copy from the Patent Office of the file-wrapper and contents of the application of said Walter K. Freeman, for an improvement in electric lamps, filed July 25, 1881, and the same is marked Defendant's Exhibit Freeman Application.

Complainant's counsel objects to the exhibit on the same grounds. 8194

3 Q. I notice, by reference to the certificate on Defendant's Exhibit Freeman Application, that the said application had been assigned to one Charles R. Flint. Please state, if you know, who this Mr. Flint was, and what relation he sustained to the defendant herein, the United States Electric Lighting Co., at the date of the said application.

Same objection.

A. He was a large stockholder in the United States Electric Lighting Co.; also a trustee in the same corporation, as well as president of the same. 8195

4 Q. What, if you know, had the United States Electric Lighting Co. to do with the prosecution of this Freeman application?

Same objection.

A. They paid the expenses of same, and through their Secretary, Mr. Curtis, advised the solicitors in 8196 that case.

Direct examination closed.

Cross-examination waived.

G. W. HEBARD.

8197 Defendant's counsel offers in evidence a stipulation made between the parties to this suit, under date of June 18, 1890; the said stipulation relating to the patent granted to Thomas A. Edison in the Kingdom of Sweden March 5, 1880, and the same is marked "Defendant's Exhibit Stipulation of June 18, 1890, re Edison's Swedish Patent."

8198 Defendant's counsel also offers in evidence printed official copies of the specifications and drawings of the following letters patent of the United States issued to Thomas A. Edison, or to The Edison Electric Light Co., as assignee of the said Thomas A. Edison, to wit:

	No. 214,636,	dated	April 22, 1879.
	" 224,329,	"	Feb. 10, 1880.
	" 227,228,	"	May 4, 1880.
8199	" 230,255,	"	July 20, 1880.
	" 238,868,	"	Mar. 15, 1881.
	" 239,151,	"	Mar. 22, 1881.
	" 239,153,	"	Mar. 22, 1881.
	" 239,373,	"	Mar. 29, 1881.
	" 248,418,	"	Oct. 18, 1881.
	" 248,423,	"	Oct. 18, 1881.
	" 248,427,	"	Oct. 18, 1881.
	" 251,540,	"	Dec. 27, 1881.
	" 251,543,	"	Dec. 27, 1881.
	" 251,546,	"	Dec. 27, 1881.
8200	" 251,548,	"	Dec. 27, 1881.
	" 263,139,	"	Aug. 22, 1882.
	" 263,878,	"	Sept. 5, 1882.
	" 264,657,	"	Sept. 19, 1882.
	" 265,311,	"	Oct. 3, 1882.
	" 265,777,	"	Oct. 10, 1882.
	" 266,477,	"	Oct. 24, 1882.
	" 274,291,	"	Mar. 20, 1883.

8197a

No. 274,293,	"	Mar. 20, 1883.
" 274,295,	"	Mar. 20, 1883
" 275,612,	"	April 10, 1883.
" 275,613,	"	April 10, 1883.
" 287,522.	"	Oct. 30, 1883.
" 307,029,	"	Oct 31, 1884.
" 358,599,	"	Mar. 1, 1887
" 370,124,	"	Sept. 20, 1887.

Defendant's counsel calls upon the com- 8198a
plainant, through its counsel here present to produce for examination by defendant' counsel, and for use in evidence in this cause if defendant be so advised, a copy of a specification, claims and drawings forming a part of the divisional application for letters patent of the United States filed in the Patent Office by Thomas A. Edison, December 15, 1880, under the serial number 264, in the serial enumeration of Edison's applications; the 8199a
said application, as appears by reference to Defendant's Exhibit File-Wrapper and Contents of Edison's Paper-Carbon Application, being a division of the said so-called "Paper-Carbon Application" filed by Edison December 11, 1879.

And defendant's counsel also, in like manner and for like purpose, calls upon the complainant to produce copies of any and all the correspondence that has passed between the 8200a
Patent Office and the said Edison or the complainant, or his or its attorneys, in relation to the said divisional application of December 15, 1880, including any and all amendments of said application that may have been made.

Defendant's counsel offers to pay any necessary expenses that may be involved in the

8197b production of the copies of the paper above-named.

Complainant's counsel states that he will make a formal reply to the request of defendant's counsel at the next session.

Adjourned till Monday, June 30, at 11 A. M.

8198b NEW YORK, June 30, 1890.

Met pursuant to adjournment.

Present—

RICHARD N. DYER, Esq., and
GROSVENOR P. LOWREY, Esq.,
Of Counsel for Complainant.
SAMUEL A. DUNCAN, Esq.,
8199b Of Counsel for Defendant.

Upon statement made by complainant's counsel that they wish to reserve their reply to the demand made at the last session for the production of a copy of Mr. Edison's divisional application of December 15, 1880, and of the official correspondence relating to the same, until they shall have had an opportunity to examine the opinion of the Supreme Court of the District of Columbia given in the
8200b mandamus proceedings, there pending, in relation to this same matter, it is agreed that this matter may stand over for the present, without prejudice to defendant's right by reason of the delay.

Defendant's counsel offers in evidence a copy of the motion herein, made on the 24th day of April, 1890, for an order compelling

8197a

the complainant to produce for cross-examination Thomas A. Edison and certain other witnesses, together with the decision of the Court on said motion, and the order thereupon entered under date of May 29, 1890, and the same are marked "Deft's Exhibit, Motion for production of Edison and others for cross-examination."

Defendant's Counsel also gives notice that 8198a
at the hearing defendant will refer, so far as it may be advised, to any or all of the affidavits upon which the foregoing motion was made.

Objected to as incompetent, irrelevant and immaterial, and especially to any and all statements of fact contained in said affidavits for competency.

8199a

Defendant's counsel also offers in evidence a copy of the papers upon which the defendant, upon the day of March, 1890, made a motion before the Court for an order directing that the complainant, its agents, servants or solicitors, consent that the Commissioner of Patents furnish to the defendant a certified copy of the file-wrapper and contents of a certain application for patent filed
in the United States Patent Office by Thomas 8200a
A. Edison, December 15, 1880; the same being marked "Deft's Exhibit, Motion for production of Edison's application of December, 1880."

Also a copy of the order, entered April 8, 1890, denying said motion, the said paper being marked "Deft's Exhibit, Order denying

8197*d*

motion for production of Edison's application of December 15, 1880."

Defendant's counsel also gives notice that at the hearing defendant will refer, so far as it may be advised, to any or all of the affidavits used upon the hearing of the aforesaid motion.

8198*d* Objected to as incompetent, irrelevant and immaterial, and especially to any and all statements or fact contained in said affidavit for competency.

8199*d* HENRY MORTON, being recalled as a witness in behalf of defendant, testifies as follows:

1 Q. State whether you have examined the description of an incandescent lamp, and the mode of making the same, which is contained in the patent in suit, No. 223,898; and also whether you have examined the provisional and complete specification of the British patents of Lane-Fox, Nos. 3,988, 4,043, 4,626, all of the year 1878, and No. 1,122 of the year 1879?

A. I have examined all the documents referred to,
8200*d* with considerable care.

2 Q. Referring to the Lane-Fox patent No. 3,988, what is the arrangement of the incandescent lamps which you find therein described; and what relation, if any, do you find therein indicated as existing between such arrangement and the resistance and the size which is to be given to the burners?

A. The arrangement of lamps there set forth is man-

ifestly what we know as a parallel or multiple-arc arrangement; and it is also clearly set forth that, in carrying out this arrangement, the resistance of the luminous conductor should be high, as compared with the other resistance involved. 8197*e*

Moreover, it is also clearly pointed out that the size of the incandescent strips or wires employed to produce the light should be small, so as to concentrate the transformation of energy in such a way as to secure its economical operation. 8198*e*

3 Q. Please compare, briefly, the construction of incandescent lamps described in the British patent of Lane-Fox, No. 1,122 of 1879, with that which is described in the patent in suit?

A. In both of these documents, I find described methods for constructing incandescent electric lamps which are in many points identical, though having certain points of difference.

Thus, in both cases, methods are described for 8199*e*
producing the burner, or incandescent luminous portion, in such a way as to secure high resistance in the same.

In both cases, this burner is to be so constructed as to be of a small size, so as to secure a concentration of action, and a consequent high intensity in the temperature produced in such burner.

In both cases, carbon is relied upon as the conducting material, the passage of the current through 8200*e*
which shall develop the high temperature and resulting light.

In both cases, this burner is to be connected with conductors of platinum wire, hermetically saled into a glass vessel, also hermetically sealed, from which all air, moisture and other deleterious substances are to be removed, prior to its being hermetically sealed.

In all these respects, the electric lamps referred to in the two documents are substantially identical.

8197*f*

As regards their differences, I find that, in the first place, the patent of Lane-Fox secures the high resistance desired, not only by making the burner of small cross-section, but also by introducing material of very low conducting power in combination with the carbon used in its construction; whereas in the Edison patent this high resistance is only secured by the length and thinness of the carbon conductor, in connection with its own resistance by reason of its porous character.
8198*f* Aside from this, there is no other distinction that presents itself to my mind between these structures, or their methods of production, unless it is the suggestion in the Lane-Fox patent that the "bridge" or incandescent conductor may be treated, by sending a current through it while immersed in a dense hydro-carbon, so as to produce on its surface a very hard film of carbon.

8199*f* 4 Q. Which of these two patents describes a burner of the higher specific resistance?

A. The Lane-Fox patent, clearly; since a mixture of carbon with a non-conducting material would manifestly have a higher specific resistance than any form of carbon alone.

5 Q. What do you understand by the statement in the Lane-Fox patent No. 1,122, that "the conducting wires are hermetically carried" through one portion of
8200*f* the glass globe?

A. That they are sealed into the glass in the usual manner, that is, by fusion of the glass in contact with them.

6 Q. You say, in answer to question 3, that in the Lane-Fox patent No. 1,122, as well as in the patent in suit, "carbon is relied upon as the conducting material." What is the warrant for this statement?

8197*g*

A. In the first paragraph of this [Lane-Fox] patent I find the following words:

> "For the manufacture of this material I employ two highly refractory materials, one of which is a conducting material, such, for example, as plumbago."

Plumbago is one of the most familiar forms of carbon, in connection with this subject; and taken in connection with the state of the art at the date of this 8198*g*
patent, I think that the expression, "such, for example, as plumbago," is equivalent to the expression *one or other forms of carbon.*

7 Q. Which, in your opinion, would be the easier lamp to make, and the better lamp when made—that described in the Lane-Fox patent No 1,122, or that described in the patent-in-suit?

A. The structure described in the Lane-Fox patent would be very much easier to construct than that described in the Edison patent. I also think that the 8199*g*
Lane-Fox lamp would be the better lamp, when it had been successfully made.

Direct-examination closed.

Cross-examination waived.

Henry Morton.

Mr. R. N. Dyer, being present under a *subpœna duces tecum* served upon him in behalf of the defend- 8200*g*
ant, and subpœnas having also been issued for the attendance, in behalf of the defendant, of J. H. Herrick and F. S. Hastings, respectively president and secretary of the complainant, it is agreed that the examination of these witnesses stand over from the time named in the subpœnas, to wit, 2 o'clock this p. m., until 2 o'clock, July 2, 1890, at the office of Duncan & Page, 120 Broadway, New York.

8197h Adjourned until Wednesday, July 2, 1890, at 2 P. M., at the office of Duncan & Page.

JULY 2, 1890.

8198h Met pursuant to adjournment.

Present—

R. N. DYER,
Of Counsel for Complainant.
SAMUEL A. DUNCAN,
Of Counsel for Defendant.

Adjourned by agreement of counsel until Wednesday, July 9, 1890, at 2 P. M., at the office of Dun-
8199h can & Page.

JULY 9, 1890.

8200h Met pursuant to adjournment.

Present—Counsel as before

Adjourned by agreement of counsel to a day to be agreed upon between counsel.

8197i

NEW YORK, August 6th, 1890.

Met pursuant to agreement, at the office of Dyer & Seely, No. 36 Wall Street, New York City.

Present: R. N. DYER, G. P. LOWREY,
For Complainant.
S. A. DUNCAN,
For Defendant.

Complainant's Counsel, referring to the demand on 8198i
behalf of the defendant made at the close of the session of June 28th for the production of certain specifications, claims and drawings, and also certain correspondence with the Patent Office, now refuse to comply with such demand.

JACOB H. HERRICK, present in obedience to subpœna
served upon him the 30th day of June, 1890, is duly 8199i
sworn, and in answer to interrogatories propounded by S. A. Duncan, in behalf of the defendant, testifies as follows:

1 Q. You are President of the corporation complainant in this case?

A. Yes, sir.

2 Q. Have you read the subpœna that was served upon you on the 30th of June, 1890, a copy of which I
now show you? 8200i

A. Yes, sir.

3 Q. Have you brought with you any of the papers therein referred to?

A. I have not, sir.

4 Q. Do you know of the existence of any such papers as are therein referred to?

A. I have made an examination and inquiry of the various under officers of the company of which I am

8197j comparatively a recent officer myself, and I have been unable to find in any of the records immediately under my control any of the papers called for here, nor do I believe any of them are among the records of the company.

5 Q. If there are any such papers such as are referred to in the subpœna, where are they to be found?

A. I believe that papers of that importance would have been immediately referred to our counsel.

8198j 6 Q. In whose hands would they now be?

A. I don't know who the counsel of the company was in 1880; I suppose present counsel.

7 Q. Do you mean Mr. R. N. Dyer?

A. Yes.

8 Q. Have you made inquiry of him to ascertain whether he has the papers referred to in the subpœna?

A. I have not.

9 Q. Will you kindly make such inquiry of him and

8199j ascertain what the fact is?

A. I have made inquiry of Mr. Dyer and he tells me that if there are in existence any of the papers described in this subpœna, they would be naturally in his possession.

10 Q. Did you ask him whether there are such papers in existence?

A. I commenced to ask him more specifically, and on advice of counsel, I decline to prosecute that inquiry.

8200j 11 Q. Then you decline, do you, to obey the subpœna, so far as that subpœna makes it incumbent upon you to inquire of the counsel who regularly would have possession of these papers, whether in fact he has such papers?

Objected to as being immaterial and irrelevant, it being quite unimportant whether the witness declines to obey the counsel's interpretation of the subpœna, and is only relevant when his answer shows whether he does or does not obey the subpœna; and this objection is made in view of the fact, which has been already stated to counsel for the defendant and is now repeated, that the witness has not any custody of papers of this sort, and that Mr. R. N. Dyer, counsel for the company now present, has custody of all such papers and stands ready to answer 8198k
whenever called upon, if such papers exist.

8197k

A. I have stated that if these papers are in existence they are in Mr. Dyer's hands, and I decline to prosecute that inquiry any further, under the advice of counsel.

12 Q. Assuming that such papers exist, and are in the hands of Mr. Dyer or any other of the counsel of the company, have you, as the chief executive officer of the company, any objection to the production of those 8199k
papers by such counsel.

Objected to as incompetent.

A. The legal department of the company is separate from the executive, and the executive would not act without the advice of counsel.

13 Q. On the assumption that such papers actually exist, and are in the hands of Mr. Dyer, or other counsel of the company, will you now direct the counsel having the custody of those papers to produce the 8200k
same?

A. Not intending any disrespect to the subpœna, but acting entirely upon what I suppose to be the legal rights of the company, and my legal rights, I, under the advice of counsel, do refuse to direct Mr. Dyer to produce those papers if any such exist, should he be called upon.

8197*l*

14 Q. Why do you refuse to do this?

A. By the advice of counsel.

15 Q. And is it also because you consider that you have no power to instruct Mr. Dyer or the other counsel in this matter?

A. Because I do not think the executive has the authority to overrule the legal department.

16 Q. Who is the "legal department" of your company, and to whom, therefore, must I apply in order to secure the requisite authority for Mr. Dyer to pro-
8198*l* duce these papers if they are in existence?

A. The general counsel of the company is Major S. B. Eaton.

17 Q. Is he vested with absolute control over this matter?

A. He is the general counsel of the company.

18 Q. In matters of this sort, is his authority superior to that of the executive department of the com-
8199*l* pany?

A. I consider that the legal advice of the counsel of the company, whether exercised by the general counsel or associate counsel, is superior to the executive in legal questions.

19 Q. Is it not competent for the executive to dismiss Major Eaton as general counsel, and select some other lawyer in his place?

A. No, sir.

20 Q. How can that be accomplished?

8200*l* A. By action of the board or the executive committee.

21 Q. The executive committee consists of whom?

A. Five gentlemen: Mr. H. Villard, C. H. Coster, E. H. Johnson, Samuel Insull and J. H. Herrick.

22 Q. Has any resolution ever been adopted by your directors giving the general counsel of the company such control over the matter referred to in this subpœna that legal papers in the hands of Mr. Dyer can

8197*m*

be produced in obedience to such a subpœna only upon the permission of Major Eaton?

Objected to as being an unwarranted prosecution of an inquisition to which the witness is not obliged to respond, it not being the duty of the complainant to furnish information upon which the defendant's counsel may make a valid claim for the testimony which is desired; and counsel for the complainant now repeat that whatever papers of the sort de- 8198*m*
scribed in the subpœna of Mr. Herrick which actually exist, are in the possession of Mr. R. N. Dyer, and have been for many years. Mr. R. N. Dyer, being now present in the room, is ready to accept service of subpœna and to take the stand and answer. The objection therefore is renewed to this inquisition, with a view to finidng out who might or might not remove Major Eaton.

Defendant's counsel replies that his only 8199*m*
object in pursuing this inquiry further with present witness is that he has been given to understand by complainant's counsel that when Mr. Dyer, who is already under subpœna to appear and produce the papers in question, is called to the stand, he will plead his professional privilege as an excuse for not producing the papers.

It is stipulated that the officers of the com- 8200*m*
pany, if successively called and asked as to the custody of the papers referred to in the subpœna addressed to Mr. Herrick, would all make the same answer as has been made by Mr. Herrick as to the actual custody of the papers if they exist, and would also, upon being asked to direct Mr. Dyer, if he has possession of such papers, to produce the

8197n same, decline under the advice of counsel to give that direction or to assent thereto. This stipulation is intended to include the executive committee of the corporation complainant, and also the general counsel of said company.

Defendant's counsel offers the subpœna shown to the witness Herrick in evidence, and the same is marked "Herrick Subpœna."

8198n Signature of witness is waived—R. N. D.

Mr. F. S. Hastings, being present in obedience to a subpœna similar to that served upon the last witness, Mr. Herrick, his examination is waived in view of the stipulation just made between the parties.

Adjourned to Thursday, August 7th, 1890, at 11 A. M.

New York, August 7th, 1890.

8199n Met pursuant to adjournment.

Counsel present as before.

Richard N. Dyer, present in obedience to subpœna served upon him, is duly sworn, and in answer to interrogatories propounded by S. A. Duncan, in behalf of defendant, testifies as follows:

1 Q. You were present during the examination yesterday of Mr. Herrick, the President of the corporation complainant?

8200n A. I was.

2 Q. Are you the Mr. Dyer referred to by him as counsel of the Edison Company, and as the person in whose custody would be the papers referred to in the subpœna, defendant's exhibit Herrick Subpœna?

A. I am the person referred to by Mr. Herrick as having such papers if they exist.

3 Q. Were you a member of the firm of Dyer & Wilbur on the 15th of December, 1880?

8197o

A. No, sir.

4 Q. The records in this case show that on the 15th of December, 1880, there was filed in the Patent Office of the United States by Mr. Thomas A. Edison, an application which was divided off from an earlier application filed by him on or about the 11th of December, 1879, the last named application being what is known in this case as the "paper-carbon application." Have you in your possession any papers relating to that 8198o divisional application filed by Mr. Edison on the 15th of December, 1880?

A. I am and for several years have been in possession of all papers relating to the applications of Mr. Edison pending in the Patent Office, and including the application of December 11, 1879, which you have referred to as the "paper-carbon application," and all divisions thereof including the one referred to. I received such possession and still hold it in the character of solicitor and counsel for Mr. Edison and the Edi- 8199o son Electric Light Company.

5 Q. Have you or have you not in your possession any papers relating to the said application filed by Thomas A. Edison on the 15th of December, 1880?

Objected to as incompetent; the witness having stated in what capacity he holds whatever papers he has, it is improper to pursue the inquiry further through him to ascertain whether or not particular papers exist. The 8200o objection is made that this question has an inquisitorial and fishing effect which is deemed improper.

A. Under the advice of counsel for the complainant, I refuse to state, more definitely than I have already done, what papers of my client I have in my possession, until I am ordered otherwise by the Court.

6 Q. You are here in obedience to the subpœna

8197p now shown you, are you not?

A. I am.

Defendant's counsel offers in evidence the subpœna referred to, and the same is marked Defendant's Exhibit "Dyer Subpœna."

7 Q. Have you brought with you any of the papers referred to in the said subpœna?

A. I have not.

8198p 8 Q. Do you know of the existence of any such papers as are therein referred to?

Objected to for the reasons stated.

A. Under the advice of counsel, I refuse to answer more specifically than I have already answered with respect to papers of my client in my possession.

9 Q. Do you refuse to produce any of the papers referred to in the subpœna?

A. On the advice of counsel, I do refuse to produce
8199p any of the papers of the character of those referred to in the subpœna in my possession, until ordered by the Court so to do.

RICHARD N. DYER.

Defendant's counsel requests the examiner to certify the record to the Court and adjourn these proceedings until the order of the Court in the premises can be heard.

Edison Electric Light Co. v. United States Electric Lighting Co.

Volume IV

Defendant's Depositions and Exhibits

Circuit Court of the United States.

SOUTHERN DISTRICT OF NEW YORK.

IN EQUITY No. 3445.

THE EDISON ELECTRIC LIGHT COMPANY

vs.

THE UNITED STATES ELECTRIC LIGHTING COMPANY.

ON LETTERS PATENT No. 223,898.

Vol. IV.

Defendant's Depositions and Exhibits.

DUNCAN, CURTIS & PAGE,
Defendant's Solicitors.

S. A. DUNCAN,
E. WETMORE,
L. E. CURTIS,
Of Counsel.

EATON & LEWIS,
Complainant's Solicitors.

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Defendant's Exhibits–Printed.

Compl't's Exhibits–Offered in Evidence.

Complainant's Exhibits–Printed.

Stipulations.

U. S. Circuit Court,

FOR THE SOUTHERN DISTRICT OF NEW YORK.

8202

THE EDISON ELECTRIC LIGHT COMPANY,
Complainant,
against
THE UNITED STATES ELECTRIC LIGHTING COMPANY,
Defendant.

In Equity No. 3445.

On Letters Patent No. 223,898.

8203

DEFENDANT'S EXHIBITS.

Defendant's Exhibit Complainant's List of Edison Lamps.

100-CANDLE POWER NEW LAMPS. 8204

No.	Volts.	Ohms.
1	112	69
2	112	72
3	112	68
4	112	68
5	112	65
6	111	73

Average resistance $67\frac{1}{2}$

Length.	Cross-Sec.
9"	.0126" x .0224"

8205

50-CANDLE POWER NEW LAMPS.

No.	Volts	Ohms.
1	109	154
2	109	153
3	109	138
4	109	143
5	109	152
6	109	144

Average resitance $147\frac{1}{3}$

8206 Length 5.8"

Cross-Sec. .0102" x .0102"

32-CANDLE POWER NEW LAMPS.

No.	Volts	Ohms.
1	108	195
2	108	210
3	108	194
4	108	193
5	108	202
6	108	200

8207

Average resistance 199.

Length 6.125"

Cross-Sec. .0065" x .0089"

24-CANDLE POWER NEW LAMPS.

8208

No.	Volts	Ohms.
1	110	294
2	110	313
3	110	303
4	110	302
5	110	310
6	110	303

Average resistance $304\frac{1}{6}$

Length 5.125"

Cross-Sec. .0056" x .0063"

8209

20-CANDLE POWER NEW LAMPS.

No.	Volts	Ohms.
1	107	445
2	108	352
3	108	324
4	108	348
5	108	365
6	107	325

Average resistance $343\frac{1}{6}$

Length 5"

Cross-Sec. .0054" z .0054"

8210

16-CANDLE POWER NEW LAMPS.

No.	Volts.	Ohms.
1	106	417
2	106	386
3	106	412
4	106	460
5	106	433
6	106	412

8211

Average resistance 420.

Length 4.75"

Cross-Sec. .0047" x .0047"

16-CANDLE POWER OLD LAMPS.

No.	Volts.	Ohms.
1	93	220.
2	93	208.
3	93	212.
4	93	217.
5	93	209.
6	93	223.

8212

Average resistance $214\frac{5}{6}$.

Length 6.25"

Cross-Sec. .0056" x .0095"

8213

10-CANDLE POWER LAMPS.

No.	Volts.	Ohms.
1	102	475
2	102	542
3	102	539
4	102	540
5	102	542
6	102	530

Average resistance 528.

Length 4.87" Cross-Sec .0042 x .0042"

8214

16-CANDLE POWER 76-VOLT NEW LAMPS.

No.	Volts.	Ohms.
1	71	143
2	71	140
3	71	148
4	71	135
5	71	165
6	71	153

8215

Average resistance 147$\frac{1}{3}$

Length 3.6 Cross-Sec .0056" x .008"

16-CANDLE POWER B NEW LAMPS.

8216

No.	Volts.	Ohms
1	61	142
2	61	146
3	61	148
4	61	146
5	61	148
6	61	143

Average resistance 145$\frac{1}{2}$

Length 3.37" Cross-Sec. .0065" x .0089"

8217

16-CANDLE POWER B OLD LAMPS.

No.	Volts.	Ohms.
1	54	63.2
2	54	72.5
3	54	70.4
4	54	63.95
5	54	71.9
6	54	70.

Average resistance 68.65$\frac{2}{3}$

Length 3.25" Cross-Sec. .0091" x .0147"

8218

30-CANDLE POWER MUNICIPAL NEW LAMPS.

No.	Volts.	Amp.	Ohms.
1	30	2.95	20.$\frac{1}{4}$
2	34	3.0	15.6
3	35	3.05	21.1
4	35	3.0	21
5	35	3.05	21
6	35.5	3.05	20.6

8219

Average resistance 19.92$\frac{1}{4}$

Length 2" Cross-Sec. .014" x .0196"

15 C. P. MUNICIPAL NEW LAMPS.

8220

No.	Volts.	Amp.	Ohms.
1	17.	3.	11.6
2	17.5	3.	12.2
3	16.	3.	10.25
4	17.	3.	10.5
5	17.	3.	11.75
6	16.5	3.	11.

Average resistance 11.21$\frac{2}{3}$

Length 1.16" Cross-Rec. .014" x .0196"

8221

20 C. P. MUNICIPAL New LAMPS.

No.	Volts.	Amp.	Ohms.
1	23.5	3.	17.8
2	23.5	3.	13.51
3	22.5	3.	12.8
4	23.5	3.	15
5	23	3.	14.5
6	22.5	3.	13.75

Average resistance 14.56

Length 1.5"

8222 Cross-Sec. .014" x .0196"

25 C. P. MUNICIPAL NEW LAMPS.

No.	Volts.	Amp.	Ohms.
1	27.5	3.0	17.1
2	27	2.95	16.2
3	27	3.0	29.25
4	26.5	3.0	16.2
5	26.5	3.0	15.85
6	27.5	3.0	15.95

8223

Average resistance 18.42½

Length 1.75"

Cross-Sec. .014" x .0196"

½ C. P. SMALL LAMPS.

8224

No.	Volts.	Amp.	Ohms.
1	3.5	1.33	4.6
2	3	1.55	2.77
3	3	1.20	3.32
4	2.5	1.19	1.7
5	3	1.55	2.69
6	3	1.32	3.54

Average resistance 3.10⅓

Length .1"

Cross-Sec. .0056" x .008"

3 C. P. SMALL LAMPS. 8225

No.	Volts.	Amp.	Ohms.
1	7.5	.94	12.2
2	11	.98	15.2
3	6.5	1.04	11
4	10	.96	14.5
5	6	1.11	10.35
6	7.5	1.33	9.3

Average resistance 12.09⅙

Length .4"

Cross-Sec. .0056" x .008" 8226

1 C. P. SMALL LAMPS.

No.	Volts.	Amp.	Ohms.
1	4.6	1.00	6.6
2	4.5	1.60	4.22
3	4.5	1.36	5.87
4	4.5	1.51	4.8
5	4.5	1.92	7.7
6	5	.86	9.83

8227

Average resistance 6.50⅓

Length .15"

Cross-Sec. .0056" x .008"

4 C. P. SMALL LAMPS.

No.	Volts.	Amp.	Ohms.
1	12	1.02	16.6
2	14.5	1.02	16.1
3	13	1.02	30.8
4	10.5	.81	23.45
5	11	1.12	16.2
6	7	1.18	10.9

8228

Length .5"

Cross-Sec. .0056" x .008"

Average resistance 19.00⅚

8229

2 C. P. SMALL LAMPS.

No.	Volts.	Amp.	Ohms.
1	6	.94	9.8
2	8	.79	15.9
3	6	.94	12.2
4	6	.93	12
5	6	.94	12
6	6	.91	12.1

Average resistance 12.3⅓

8230 Length .25" Cross-Sec. .0056" x .008"

6 C. P. SMALL LAMPS.

No.	Voltsr	Amp.	Ohms.
1	12	1.64	12.5
2	11	1.86	12.1
3	12	1.62	12.35
4	12	1.75	12.55
5 8231	12	1.50	13.2
6	12	1.75	12.6

Average resistance 12.55

Length .6" Cross-Sec. .0045" x .014"

SURGICAL ½ CANDLE POWER.

8232

No.	Volts.	Amp.	Ohms.
1	26	1.355	3.04
2	26	1.155	3.8
3	23	1.365	3.04
4	25	1.065	6.56
5	25	1.505	3.47
6	27	1.065	4.43

Average resistance 4.05⅞

Length .1" Cross-Sec. .0056" x .008"

½ CANDLE POWER PEA LAMP. 8233

No.	Volts.	Amp.	Ohms.
1	4.5	.92	8.3
2	2.5	2.45	1.79
3	4.5	.92	8.6
4	4.5	.98	6.23
5	2.5	1.78	2.19
6	3	1.23	3.7

Average resistance 5.135

Length .1" Cross-Sec. .0056" x .008" 8234

½ CANDLE POWER DENTAL LAMP.

No.	Volts.	Amp.	Ohms.
1	3	1.50	3.32
2	4	.82	7.94
3	4	.84	5.66
4	6	.70	21.25
5	4	1.12	5.45 8235
6	4	1.30	4.2

Average resistance 7.95⅓

Length .1" Cross-Sec. .0056" x .008"

20 C. P. MUNICIPAL OLD LAMPS.

No.	Volts.	Amp.	Ohms.
1	19	3.5	10 8236
2	18	3.5	9.4
3	22	3.5	11
4	18	3.5	9.4
5	20	3.5	10.1

Average resistance 9.9⅓

Length 1.33" Cross-Sec. .0148" x .0217"

8237

16 C. P. 3.5 AMPERES OLD LAMP MUNICIPAL.

No.	Volts.	Amp.	Ohms.
1	15	3.5	8.1
2	15	3.5	7.8
3	16	3.5	8.2
4	15	3.5	7.8
5	15	3.5	7.8
6	17	3.5	8.2

8238

Average resistance 7.9

Length 1.33" Cross-Sec. .0148" x .0217"

RESISTANCE LAMPS.

8239

Ohms. 8.5

Length 5.87" Cross-Sec. .035" x .070"

These are used as resistances with arc lamps.—**Not** intended for lighting.

8240

8241

Defendant's Exhibit Du Moncel's Article on Geissler-Tube Lamps.

NOTICE SUR L'APPAREIL D'INDUCTION ÉLECTRIQUE DE RUHMKORFF.

Par le Cte Th. du Moncel.

Cinquième edition.

Paris. 8242

Gauthier-Villars, Imprimeur-Libraire.

1867.

IV.—Application de l'appareil de Ruhmkorff à l'éclairage.

Application à l'éclairage des cavités obscures du corps humain.—Voici comment M. Fonssagrives, médecin en chef de la marine à Brest, rend compte de cette application : 8243

"Depuis longtemps, dit-il, j'avais concu la pensée que la lumière électrique pourrait être fructueusement substituée, dans certaines recherches de diagnostic ou dans certaines manoeuvres opératoires, aux procédés ordinaires d'éclairage qui sont insuffisants pour l'intensité et la radiation lumineuse, ou défectueux par la coleur de leur lumière, ou gênants par l'impossibilité de les employer sans masquer le champ d'action des instruments et par la nécessité, à cause de la vive chaleur qu'ils projettent, de les tenir à grande distance de la surface à éclairer. 8244 Tout le problème se réduisait donc à trouver une source lumineuse qui n'eût que peu ou point d'action calorifique, qui pût être condensée dans des tubes peu volumineux et de forme diversifiée enfin qui fut d'une grande blancheur,

[NOT FILMED: PAGES 2062-2069]

8277

Translation.

IV Application of the Ruhmkorff Apparatus to Lighting.

Application to the lighting of obscure cavities of the human body

8278 M. Fonssagrives, chief physician of the navy at Brest,
explains this application as follows:
"A long time since," he says, "I conceived the idea
"that the electric light could be advantageously sub-
"stituted in certain examinations in diagnosis or in
"certain manipulations in operations, for the ordinary
"methods of lighting, which are insufficient in intensity
"of luminous radiation or defective in the color of the
"light, or troublesome on account of the impossibility
"of employing them without interfering with the field
8279 "of action of the instruments and by the necessity,
"arising from the high heat which they give, of keep-
"ing them at a great distance from the surface to be
"lighted. The whole problem was reduced then to
"finding a luminous source which had but little or no
"calorific action and which could be condensed in
"tubes of small volume and of diversified form, and
"which was, finally, of great whiteness in order not to
"change to the sight the color of the organic tissues
"lighted by it.
8280 "Thanks to the enlightened assistance M. Th. du
"Moncel and M. Ruhmkorff have given me, the pro-
"blem has been solved in a satisfactory manner. M.
"du Moncel having remarked that the Geissler vacuum
"tubes are not heated under the influence of the elec-
"tric light which traverses them, and knowing, more-
"over, that this light itself is the more brilliant as the
"communicating tubes between the terminal bulbs of

8281

"the apparatus are of smaller diameter, M. du Moncel
"thought that by taking an apparatus of this class in
"which a long, almost capillary, tube was folded up-
"on itself and arranged after the manner of electro-
"magnetic multipliers, he could obtain not only a sort
"of luminous cylinder susceptible of being introduced
"into quite narrow cavaties, but also a sort of electric
"lantern in certain points of which the light could be
"concentrated without cause for apprehension on that
"account, of either heating or disturbance. The first 8282
"part of the problem was thus solved. As to the
"color of the light in these tubes, as that depends en-
"tirely on the nature of the gas with which the vacuum
"is produced, and as it is white when certain mixed
"gases, such as hydro-carbon, carbonic acid, hydro-
"chloric acid, etc., are used, it was only necessary for
"solving this second part of the problem to prepare
"tubes with proper gases. M. Ruhmkorff, to whom
"the construction of these tubes was entrusted, has
"reached, by means of a certain mixture of gases which 8283
"he keeps secret, results altogether satisfactory, and
"experience has demonstrated that the light furnished
"by this apparatus *is more than sufficient* for the re-
"quirements of the physician and the surgeon. With-
"out wishing at present to outline in an absolute man-
"ner the field of the applications of this new method
"of lighting organic surfaces, we may, nevertheless,
"say that it can serve in general: 1st, for a diagnostic
"exploration of accessible organic passages: 2nd, for 8284
"aiding experimental work.
"Under the first head we are able to report the ex-
"amination of the nasal canals for determining the
"presence either of ulcerations, or of a perforation of
"the partition, or of polypes of different kinds; the
"exploration of the upper part of the larynx for de-
"termining the condition of the epiglottis and of the

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"posterior wall of the pharynx in the cases so fre-
"quently occurring of granular pharyngitis; the ex-
"amination of the back part of the mouth for deter-
"mining the nature and the extent of certain inflam-
"mations. I have a plan of having constructed for this
"exploration a photo-electric tube of a sufficiently small
"calibre to be introduced after the manner of a Belloc
"sound along the lower surface of the nasal
"canals in such manner as to light the pharynx from
8286 "above downward, leaving the mouth completely free.
"The same mode of lighting can be applied to the
"examination of the valvo-vaginal canal and of the neck
"of the uterus. In the case of vesico-vaginal fistulas a
"photo-electric tube in the form of a female sound
"would be introduced by the urethral canal, and the fil-
"tration of the light through the fistular opening would
"be projected upon a metallic plate graduated in milli-
"meters and introduced into the vagina so as to give a
"very exact idea of the distance to which the fistula ex-
8287 "tends. In the same way an examination of the rectum
"can be made after the introduction of the *speculum*
"*ani*, to determine the position of the fissures of the
"intestinal orifice etc. An examination can also be
"made in the same manner of the tympanum and of
"foreign bodies or concretions in the auricular con-
"duit. Still further, we can thus determine the posi-
"tion of certain tumors, diagnose by an immediate and
"direct apposition the transparency of the hydrocele,
"ascertain if an inguinal hernia is only an epiplocele
8288 "or contains at the same time a portion of the intes-
"tine.
"As to the lighting of organic canals as a means of
"guiding instruments, the entire utility of this method
"is foreseen in operations which present, among a
"number of other difficulties, the greatest one of the

8289
"impossibility of conveniently lighting the surfaces
"upon which the instruments are to act. We may
"cite as those which are particularly to profit from
"this new application: 1st, staphylorrhaphy: 2d, the
"operation of vesico-vaginal fistula by the American
"method: 3d, the extirpation of naso-pharyngeal or
"uterine polypes: 4th the excision of amygdales, etc
"Finally the inquiry may also be made whether, in
"opthalmoscopic researches, these tubes would not 8290
"light in a completer and more ready manner the field
"of the retina.
"These applications are not, moreover, the only
"ones to which these luminous tubes may be applied.
"M. du Moncel says that they would also find advan-
"tageous employment in the industrial arts, for exam-
"ple, for the lighting of the cross-wires of astronomi-
"cal instruents; for the lighting of obscure places and
"of certain points where the light of a candle cannot
"be introduced, circumstances which are continually 8291
"presented in mechanical and industrial apparatus:
"for the lighting of mines, even, these lanterns could
"be, according to him, substituted with advantage
"for the Davy lamps."

Application to the lighting of the galleries of mines.

Since the presentation to the Institute of my tubes
for the lighting of obscure cavities of the human body.
I have, as we have just seen, indicated as an object for 8292
the application of this apparatus the lighting of the
galleries of mines, which, as we know, are so much ex-
posed to the disastrous effects of fire damp. MM. Dumas
and Benoit have carried out this idea by arranging these
tubes in an altogether practical way, as is seen in Fig.

115. These gentlemen describe their apparatus as follows:

Fig. 114.

8294

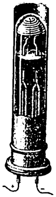
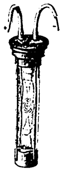


Fig. 115.



8295

"We do not claim the honor of having been the first
"to conceive the idea of applying a new method of
"lighting for use in mines; but, after considering much
"information with which we were furnished, we con-
"cluded that nothing practical of this kind had been
"produced up to this time. As to the nature of the
"method of lighting which we have chosen, it is not
"the first time it has been utilized. M. du Moncel has
8286 "already made a practical application of it when he
"conceived the happy idea of introducing lighting
"tubes of a particular form into the buccal canal in
"order to be able to examine the different parts. We
"were ourselves present at the experiments of Messrs.
"Depretz at the Sorbonne, and Gavarret at the School
"of Medicine, and it is to the recollection which we
"retain of the effect of this light that we attribute the
"idea which we have conceived of applying it to the
"use of mines.

"Our apparatus is composed of three essential
"parts: 1st, a battery element: 2d, a Ruhmkorff coil:
"3rd, a lighting tube placed in a sort of cylindrical
"lantern; the whole arranged in such manner as to
"produce a light sufficient for lighting the miner and
"and permitting him to work, even in places where
"other lamps are extinguished. It is evident that all
"these pieces of apparatus are arranged in casings suf-
"ficiently strong so as not to fear mechanical shocks,
"nor lack of care of the workman and to be easily 8298
"transportable.

"The light produced is cold, or rather, does not
"heat the tube in which it is produced, and it is inac-
"cessible to gas. The entire apparatus is perfectly
"insulated; it is quite as strong as the lamps which
"are in use. No noxious emanation or inconvenience
"is perceived; it can be extinguished or lighted in-
"stantly at will.

"The apparatus is capable of working at least for 8299
"twelve hours consecutively without diminution of
"light, and without having to change anything. The
"workman has only to stir up the carbon of the bat-
"tery at long intervals by means of a stick.

"The greatest difficulty consisted in being able to
"combine a battery of such power and a coil con-
"structed in such manner that the size and the weight
"of the apparatus should be as small as possible; that
"the light produced should have the greatest regular-
"ity and a duration of at least twelve hours. But our 8300
"apparatus, of which we are certain that we can re-
"duce the dimensions still more, is already of suffici-
"ently small size so that the miner can carry it with-
"out trouble, like a small hunting bag; that he has
"both hands free, or he may hold in one of them the
"luminous tube, which he will be able to detach at
"will for exploring more carefully.

8301

" The cases to which this mode of lighting is appli-
" cable are numerous and important. We have men-
" tioned coal mines, we will add salt mines in which
" fire damp sometimes appears, mines of bituminous
" schists, gas works, when it is required to repair the
" retorts, sewers, when there is occasion to clean or
" visit them, works for the manufacture of chemical
" products, alcohol and shists; arsenals and powder
" works; vessels, when the light cannot be kept going
8302 " in the wind, or when it is necessary to go to places
" which contain explosives; in war, for certain night
" reconnoissances, and by the aid of a particular me-
" chanism adapted to the coil, the same apparatus will
" serve the soldier for exploding several mines at the
" same time and instantaneously. The advantages of
" being able to extinguish and light it at will, will be
" in certain cases, of great utility. Finally, by means
" of the combination of the respiratory apparatus of
" Rouquayrol with ours, any workman will be able from
8303 " this time on to live and have light in all security
" where he could not otherwise do so.

" The lamp which we have represented in Fig. 115
" is easily understood. It is a sort of eudiometric tube
" of crystal terminated by two caps of copper which
" are connected together by means of four metallic
" rods. Inside of this tube is fitted the lighting ap-
" paratus of which we have spoken in the preceding
" chapter. But it is of larger dimensions, and its two
" extremities are united to two copper caps upon which
8304 " are fitted the flexible conductors which connect the
" lamp with the induction apparatus. These caps are
" covered, as is the lower part of the lamp, with rub-
" ber, and the conductors themselves are surrounded by
" tubes of the same material. The apparatus, more-
" over is suspended in the air by its conductors, as is
" seen by the drawings.

8305

" Originally, in order to obtain a white light a vacuum
" was made in the lighting tube by exhausting car-
" bonic acid; but as, after a certain time of continued
" service, this gas is decomposed, it is preferred to
" employ for the construction of these tubes, only
" simple gases, and of these nitrogen has been select-
" ed. Only, in order to correct the red color, the coil
" through which the light is multiplied has been made
" of uranium glass. The light is then made greenish, 8306
" but of a greater intensity.

" The battery and the coil are put together in a sort
" of leather cartridge box, which is carried by a should-
" er strap like a hunting bag, and the whole weighs
" about 5¼ kilogrammes.

" This apparatus has been put in use in the coal
" mines of Besseges, Rochebelle, of the Grand 'Combe
" and of Allais, by M. Parran, engineer of the mines,
" who has shown himself to be very well satisfied
" with it. 8307

" According to this engineer, the intensity of the
" light of this apparatus, which is a little inferior to
" that of an ordinary safety lamp, becomes equal to it
" when this latter has burned for several hours and
" surpasses it in badly-ventilated galleries.

" It causes no danger of explosion, even supposing
" the tube to be broken in an explosive mixture; for
" the distance of the electrodes being at least 17 centi-
" meters the spark could not be produced.

" In order to arrive at an understanding of the util- 8308
" ity of this lamp we report the two following exam-
" ples cited in the work of M. Parran.

" In the first operations of rescue in the mines of
" Lalle, the greatest difficulty was to light the pits
" which were excavated for delivering two workmen.
" The lamps were extinguished without cessation and
" it needed a chain of men for their transmission and
" relighting, and without the hearty assistance of the

8309

"neighboring works, the succor would not perhaps "have met with so prompt a success.

"An electric lamp placed at the head of each work-"ing would have avoided these troubles. Later, more "than two hours were taken for getting out the third "of the three men who were saved after fourteen "days of anguish, because it became necessary to "light the passage and lay ventilating tubes for mak-
8310 "ing the lamps burn. The work would have been ac-"complished in ten minutes with an electric lamp."

"*Application to the lighting of the bottoms of ships under the water.*—M. Mallet, captain of a vessel, has furthermore made an important application of lighting tubes coiled upon themselves, for the lighting of the work of repairing the hulls of ships. Fig. 114, represents the arrangement of these tubes, which resembles in other respects those of which we have just
8311 spoken. Nevertheless, as the lighting should be local, M. Mallet has arranged them like those which I have had constructed, that is to say, in such a way as to concentrate all the light at the extremity of the tube; it suffices then to present the tubes at that end for lighting directly the part of the ship damaged. It is above all for replacing nails and bolts that the light is most useful.

Application to the lighting of buoys.—The idea has also been conceived of applying the light produced by
8312 the spark produced by the Ruhmkorff apparatus to the lighting of buoys for serving as guides during the night about the entrances of ports, but this kind of of light is so low in intensity that it appears to us quite difficult to apply it advantageously for this object. However this may be, we have considered that we ought to make a note of this application.

8313

Defendant's Exhibit Extract from Noad's Inductorium.

THE INDUCTORIUM OR INDUCTION COIL.

by

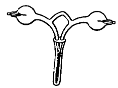
HENRY M. NOAD.

8314

John Churchill & Sons, New Burlington street, London, 1868.

Fig. 47.—This form of tube is intended for medical use; it furnishes the practitioner with an excellent

FIG. 47



8315

and convenient means of examining the throat, for which purpose the tube enclosing the spiral is introduced at the mouth, and the inductive discharge passed through the bulbs, which have been filled with carbonic acid and well exhausted; a brilliant white light is produced, which illuminates the interior of the mouth and throat.

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8317

Defendant's Exhibit Evening Post Article of November 12, 1878.

The New York Evening Post, November 12, 1878.

WHAT EDISON IS ABOUT.

8318 The Electric Light an Accomplished Fact.
Only Waiting for the European Patents.
Facts About Its Cost and Management.

(Correspondence of the Evening Post.)

PHILADELPHIA, November 11, 1878.—In conversation with an eminent scientific gentleman in this city, who is an intimate personal friend of the inventor Edison, I learned a number of interesting facts bearing on the future of the much-discussed electric light. My in-
8319 formant, who has just returned from a visit to Menlo Park, assured me that the light was entirely ready for introduction in general use, and that the company were simply waiting for the European patents, which the English solicitors have just telegraphed them will not be ready under twenty days. The apparatus is standing complete in Edison's workshop, and I am assured gives a soft, beautiful light of the same strength as gas. The question of relative expense is, of course, yet somewhat a speculative one, but the highest esti-
8320 mate makes the cost one-half that of gas.

HOW IT WILL AFFECT GAS COMPANIES.

In answer to my inquiry how this revolution would affect gas stocks, my informant thought that while gas must ultimately go out of use, the enormous existing plant of gas and the great interests involved would for a long time contest the claims of the new light to popular favor. He thought the gas plant could not be

8321

used to any considerable extent in distributing the electric light, but that this work must be practically done *de novo*, as it would cost as much to adapt the gas pipes and jets to electricity as to supply new apparatus. Edison's jet, he says, is very neat and all the contrivances very simple. Even at the same cost or greater, the electric light will be preferable. In its use there will be a less expensive plant, and there will be an absence of heat and danger, while the running expenses will be insignificant.

8322

THE INVENTOR AT HOME.

As the trains on the Pennsylvania Railroad speed to and fro between Philadelphia and New York, no station and no beauty of nature calls for such general attention as the few humdrum houses and the bleak scenery of Menlo Park. Passengers eye the station with almost bated breath as the new scientific shrine. In this village, which Edison has rendered so famous, the "wizard" lives and works, as artfully protected as may 8323
be from the intrusive curiosity of a wonder-loving and hero-worshipping world. Some of the precautions adopted are indicative in their ingenuity and originality of the man. Telegraph wires connect his shop with the station, and the arrival of a stranger, especially if he bear the family likeness of the purveyor of news, is heralded by the lynx-eyed station patrol. Thus forewarned and forearmed the inventor has other defences yet to shield him from the dreaded "interviewer." Bolts, bars, forbidding legends, and polite assistants 8324
and servants stand like lions before the house beautiful in the "Pilgrim's Progress." But once reached, the inventor is found the most genial and unaffected of men. His health is now fully restored, and he is as hard at work as ever. The attempt to anticipate his light by a rival company does not ruffle him in the least, as he is confident of the superiority of his inven-

8325 tion, and, moreover, the two companies will occupy rather different fields.

I judged, then, from these remarks of a gentleman eminently qualified to speak on the subject by his professional knowledge of the subjects involved and his personal intimacy with Edison, that the electric light as an interior illuminator, filling the place of oil and gas, is a sure fact in the near future. My informant scouted the idea that Edison had been used by specu-
8326 lators to affect the gas stock market. He believed these stocks would temporarily recover from the present panic, but there was no question as to the genuineness and the entire success of the new light.

H. R. E.

Defendant's Exhibit Sun Article of November 25, 1878. 8327

THE SUN, NEW YORK, NOVEMBER 25, 1878.

THE NEW ELECTRIC LIGHTS.

What Mr. Edison thinks of the Recent English Invention.

Rio Janeiro First to use the Light—Mr. Edison on
8328 Werdermann's Carbon Light—A Wonderful Improvement on the Telephone—A Marvellous Typewriter—A Patent secured through the use of the Atlantic Cable.

A small American flag fluttered from the roof of the new engine house in the rear of Mr. Edison's Menlo Park laboratory on Saturday. The building is nearly

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completed. The boiler is in position, but the engine remains on the platform cars near the depot. A score or more of men are at work in the yard, and every possible preparation is being made for the decisive experiment with the electric light. The inventor's faith in the practicability of his invention is shown by the estimated cost of the experiment. He purposes to start in at Menlo with 2,000 lights, using telegraph poles with 15 lights on each arm. This experiment, including the cost of the buildings, engine, generating 8330
machines, and everything, he thinks, will eat up from $75,000 to $100,000. One of his assistants says: "I always go on the principle of adding thirty per cent. to the estimated cost of all experiments, and find myself nearer right in the end. It will cost nearer $125,000 than $100,000 to make this experiment at Menlo." Mr. Edison nodded his head approvingly. "Whatever the cost," he said, "it will prove the practicability, cheapness, and utility of this subdivision of the elec-
tric light beyond a doubt." 8331

The downfall in gas stocks has been followed by a corresponding increase in the price of shares of the Edison Company. It is understood that 260 has been offered and accepted. The men at Menlo say that they are told that the stock of a prominent gas company was recently offered by auction at Nicolay's in Wall street. The highest bid was seventy. The shares were withdrawn.

On receiving this information the writer said that a 8332
well-informed Wall street gentleman thought the purchase of gas stocks was the best investment that a moneyed man could make at this time. He thought they had touched bottom, and would rapidly come to the surface under the influences exerted by the printed opinions of Prof. Morton and other savants. Morton's articles had excited grave doubts as to the utility of Mr. Edison's invention. But even supposing that the

8333 Edison idea was practicable there was always the chance that the inventor might die and his invention relapse into obscurity for want of development.

Mr. Edison tore a soiled silk handkerchief from his neck, and laughed outright.

"Has this Wall street gentleman any money" asked one of his assistants?

"I don't know," was the answer. "Why do you ask?

"Because if he has any money, and backs up his
8334 opinion with it, he's sure to lose it," he said.

THE RECORDS OF THE EXPERIMENTS.

Mr. Edison broke into the conversation. He seemed to think that Prof. Morton owned gas stock, or was writing in the interest of the gas companies, although he gave no expression to such an opinion. His assistants, however, freely uttered their suspicions. "My
death," said Mr. Edison, "could not destroy the utility
8335 of my invention. The thing is proved to be of practical use. I keep a record of each experiment, and file away every drawing. Not an etching or scrap of paper is destroyed. Batch," turning to one of his assistants, who was figuring out a problem, "show him the records of our experiments with the electric light."

Batchelor disappeared and returned staggering under a load of books and foolscap paper. They would have made the eyes of an old paper-man dance with
delight. There were over a thousand sheets of draw-
8336 ings alone. A notary's seal was stamped on each sheet. A stranger might have taken them for a manuscript edition of Euclid sandwiched between scores of algebraic equations. The record was complete. There was not a lapse. "There they are," continued Mr. Edison. "Look them over for yourself. Before we get through with our experiments on this light we shall have a pile of papers that will reach from the floor to the ceiling."

Confident himself in the success of his invention,

Mr. Edison seems pleased with indications of public 8337
confidence. The well-known firm of Fabbri & Chauncey have bought from the Edison Company the exclusive right to the use of the new electric light in South America. From one of the officers of the steamship City of Rio Janeiro, the writer learns that the contract for lighting the Brazilian capital expires very soon. In view of the franchise bought by Fabbri & Chauncey, he thought it not improbable that Rio Ja-
neiro might be the first city in the world lighted by 8338
electricity.

THE RECENT ENGLISH INVENTION.

In further conversation I alluded to reports that gentlemen in England and France had discovered means for the subdivision of electric light. I drew from my pocket a slip from the London *News* announcing that England, and not America, had solved the great problem of the divisibility of this light. A
Mr. Werdermann had given a public exhibition of an 8339
invention for lighting with a divided electric current. The current was generated by means of a two-horse power Gramme's plating machine, and was conducted along a cable serving to light two lamps, stated to have the illuminating power of about 360 candles each. The light which was perfectly steady, and in the room was soft and sunlike, could be looked at without discomfort, though it was not shaded. The next thing, the larger lamps being extinguished, was the exhibition of ten smaller lamps,
fed by the same current. From the cable, which 8340
might be said to represent a gas main, a wire, answering to a service pipe, ascended to the positive electrode of each light. The construction of the lamp may be thus described: An upright rod of carbon (the positive electrode), resembling an ordinary slate pencil, touching the centre of the under side of a disk of carbon (the negative electrode) which was somewhat like

8341 a half-pound weight. Briefly, the lamp may be roughly compared to a common weight balanced on a sharpened slate pencil. A balance suspended from the apparatus served to keep the positive electrode in its place as the carbon would be consumed. Another cable and a special wire united all the negative electrodes, and at the last lamp the current went to earth. The connection having been made, the ten lamps were at once lighted; each light was stated to be of about
8342 forty candle-power. The lamps burned steadily, with a beautifully soft and clear white light. First one of the ten lights was then extinguished, and afterward a second, the only effect to the remainder being that they became slightly more brilliant, as gas will sometimes be under similar circumstances. Mr. Werderman explained that this would not really be the case, as there would be an arrangement by which, on the extinction of a light the current would be directed along a supplementary wire, equal in resistance to the
8343 consumption of the light, so that the resistance in the case of the other lights on the circuit would remain unaffected.

Mr. Werdermann, with the aid of diagrams, explained his invention. It was well known, he said, that when they burned an electric light of two carbons, one carbon burned out in a crater, while the other burned to a point; thus the one carbon was consumed twice as fast as the other. It occurred to him to find out what change would take place if he
8344 varied the section of the electrodes—that was, if he made one carbon smaller and the other larger. He then discovered this curious fact, that when he had an electric arc of one inch he could not maintain that arc if he diminished the section of his positive carbon. He went on reducing the section or magnitude of his positive carbon, the electric arc becoming lessened in regular proportion, until the difference of section of

the two electrodes was as one to sixty-four, and then 8345
the electric arc was so far reduced that the two carbons were in contact. As the section of the positive carbon was diminished, the glowing portion of that carbon increased in length, while the heat imparted to the negative carbon was reduced. In effect, when the sections of carbon had reached the relative proportions just stated, and were in contact, the electric arc was infinitesimally small, the negative electrode was not
consumed while the positive electrode was incandes- 8346
cent. Light was therefore not only supplied by the electric arc, but was also furnished by the incandescent carbon of the positive electrode. It then only required a simple mechanical arrangement to keep the positive pole, as it consumed, in regular contact with the negative pole, and the difficulty which had hitherto stood in the way of using a number of lights from one current was overcome.

"Have you seen any account of this invention?" I
asked. 8347

Mr. Edison smiled, and laid before me an English weekly newspaper, containing a fully illustrated description of the Werdermann subdivision. "For your information," he said, with a quiet chuckle. It was carefully read, and did not vary materially from the account given above.

MR. EDISON ON THE WERDERMANN LIGHT.

Mr. Edison then said: "This Werdermann light
neither forestalls nor conflicts with my invention. I 8348
use no carbon. My light does not burn itself out. The Werdermann light, however, is a good thing. It allows more subdivision than the Jablochkoff; but the maintenance of attention and consumption of carbon cost more than the horse power used to keep it running. It doesn't allow of a reliable subdivision."

"Why doesn't it?" I asked.

8349 "Because," said Mr. Edison, "You must keep fooling with the lamp all the time to keep it going. To be of utility, the subdivision must be absolutely constant. As a carbon lamp I like it very much. But the carbon lamp won't do. I have made repeated experiments with carbon, and at one time made a lamp very similar to this one of Werdermann's."

"Then you think Werdermann's invention of no
8350 practical utility?"

"No, I won't say that," he replied. "It may come into use in many places, but it can never become of general use. The lamp for the people must be so simple in its construction that any fool or mule can use it. I am making such a lamp. You turn your faucet, and there is your light. You turn your faucet and your light is gone. There is no dickering and no feeding. Your light is there when you want it, and when you don't want it it disappears. It is so simple in its
8351 design that a child can understand it and use it, and it costs no more than the horse power used to turn the generating machine. The current is noiselessly carried from one light to the other, and there is no rush or frying-pan sizzle as is the case with the carbon points. And then there is the question of supply. With a four-cell battery I can get more light with my invention than any carbon light so far devised, with the same amount of electric force, and I can see nothing to prevent its application to stronger currents on a
8352 larger scale."

PATENTS BY CABLE.

The loud ticking of a telegraph instrument interrupted the conversation. We were seated in the little office off the main entrance to the laboratory. Mr. Edison ran to a telephone boxed on the wall. I could hear a womanly voice informing him that dinner was ready. He resides an eighth of a mile from the

laboratory. "All right" he responded, and resumed the conversation. 8353

"These fellows across the water are working the light for certain," he said. "I see that seven patents were granted in England alone between Oct. 29th and Nov. 4th. About one-tenth of all the patents now taken out in Great Britain are for electric lights. I patent all the discoveries made in my experiments both here and in England. And sometimes we make quick work of it. Last week I made a discovery at 4 o'clock
in the afternoon. I got a wire from here to Plainfield, 8354
where my solicitor lives, and brought him into the telegraph office at that place. I wired him my discovery. He drew up the specifications on the spot, and about 9 o'clock that night cabled an application for a patent to London. Before I was out of bed the next morning I received word from London that my application had been filed in the English Patent office. The application was filed at noon, and I received my information about seven in the morning, five hours be-
fore the filing. The difference between London and 8355
New York time explains the thing."

NONSENSE AND COMMON SENSE.

Mr. Edison says that the cost of this manœuvre did not exceed eighty dollars. He thought that the total cost of his electric light patents might amount to $17,000. A minute afterwards he picked up the slip from the London *News*, and quickly became interested. His eyes lighted with humor, and a smirk encircled his
mouth. "Now, look here," said he, reading from the 8356
slip.

"Mr. Werdermann stated that he did not believe in the principle of the indefinite division of a current of equal strength, which Mr. Edison has been said to affirm."

"Well," he drawled, "as Lord John Russell said,

8357 the sources of the information obtained by her Majesty's Government are quite incomprehensible. I don't and never did affirm any such nonsense as that. It is nonsense on its face." He read further:

"In his (Mr. Werdermann's) opinion a current equal to maintaining a hundred lights would not maintain five hundred lights any more than an amount of gas only sufficient for a hundred burners would supply five hundred burners. But, he added, the proportion of
8358 horse-power absorbed by each light would be less, as the number of lights was greater. The greater the number of lights the greater would be the quantity of the current required, and the longer the distance traversed by the current the larger must be the electromotive power."

"That's common sense," added Mr. Edison. "No sane man can doubt it."

"I understand," I said, "that you propose to feed a certain number of lights from one current of elec-
8359 tricity. Now, when that current strikes the first light, and what is not wanted is carried on to the next lights, would it not be a great deal stronger than when it reached the last light? Might it not be so strong as to melt the contrivance used to send it on if it did not melt the burner?"

"You can only carry so much water through a two-inch pipe," he answered. "A certain amount of gas will go through a gas main, and no more. A wire will take only so much electricity. We arrange the con-
8360 ductor in such a manner that the current at all points is the same, and that is all there is of it."

SIX LIGHTS TO ONE HORSE-POWER.

In further conversation, Mr. Edison said he was getting four times as much light with the same force as he did when he first began his experiments. He found the generating machines in use faulty, and was making two

improved machines of his own, with the view of turning the greatest amount of horse-power into electricity 8361
with the least possible loss. These machines are to be especially applicable to his electric light. From his experiments he was satisfied that he could get three lights equal to an ordinary gas jet for each horse power with each old generating machine, and six with the new machines. The writer then called the inventor's attention to the following extract from the London correspondence of the Liverpool *Post*:

"Some important information has reached me on the 8362
nature of Edison's electric light. It is formed by a coil of platinum being placed over a wire heated by the electric current. The coil itself is the source of light, the current sent through it being strong enough to make it white hot and self-luminous. The difficulty to be overcome at this point of the invention was the liability of the wire to fuse and spoil the light—a difficulty which Mr. Edison claims to have obviated by the introduction of a simple device, which by the expan- 8363
sion of a small bar the instant the heat of the coil approaches the fusing point of the platinum, interposes as a check to the flow of the current through the coil. This automatic arrangement secures, it is said, an even flow of electricity through the coil, and consequently a steady flow of pure light."

"This was evidently written," said Mr. Edison, "by some one who had seen one of my earliest experiments. It does not tally at all with my latest light. There is no bar, and the whole thing is entirely different. I fancy that I can soon give a complete explanation to 8364
the public. Batch., where is the lamp that this article evidently refers to?"

Mr. Batchelor hunted it up. It was found among the cast-off experiments, broken and dusty, and was exhibited amid the laughter of Mr. Edison's assistants

The telegraphic instrument again began to tick, and

8365 the sooty savant jumped to the telephone. The womanly voice repeated that dinner was ready. "Never mind," shouted Mr. Edison in response. "Can't you send up a lunch for three?"

ENGLAND AWAKE.

He received a faint answer, but owing to his deafness did not hear it. "Hallo, hallo!" he shouted. The womanly voice answered. "Send up a lunch for
8366 three!" he cried, and resumed his seat. Mr. Batchelor handed him a slip from the London *Times*. He passed it to the writer, saying: "Do you remember the controversy in England concerning the merits of the carbon telephone? Hughes and Priest of the British Postal Office both condemned it. Hughes said it didn't work at all. Well, now read what the British Thunderer says about it."

The extract was cut from the London *Times* of Nov. 12. It gives an account of "some interesting and valu-
8367 able experiments on electric telephony, between Norwich and London, under the most adverse circumstances of bad weather and powerful induction of neighboring wires. "These experiments," the *Times* says, "had for their object the confirmation of some extraordinary statements that had appeared in the American journals respecting the ability of the carbon telephone, one of Mr. Edison's numerous inventions, and perhaps one of the most important, to work over great distances and under conditions favorable to other sys-
8368 tems—conditions which up to the present time have been the chief obstacle in the practical use of electric telephony." The wire stretched from Messrs. Colman's works in Norwich to their office in London, or a little over 115 miles. It ran over the same poles as other wires. When the experiments began, the incessant crackling and bubbling sounds in the receivers revealed the fact that the adjoining wires were being

worked to their fullest capacity, and that induction 8369
could hardly be worse. The first exclamation uttered in Norwich was heard perfectly in London. Conversation was carried on without difficulty, and the Yankee accent of Mr. Edison's agent was distinctly recognizable. Remarks passed on the weather showed that there was a storm of sleet at both ends. The conversation was best heard when carried on a little below the ordinary tone of voice. Toward 9 P. M. the induction disturbances grew less, but were still consider- 8370
able. The voices from Norwich were louder, and the individuality of the speakers more marked.

ASTOUNDING DISCOVERIES.

Commenting on these experiments, the *Times* says:

Remarkable as they were, they appear to be outstripped by what has been achieved in America through the same instruments. Mr. Prescott, the chief electrician of the Western Union Telegraph Company, 8371
says that they have been successfully used when included in a Morse circuit, and that several stations could exchange business telephonically upon a circuit that was being worked quadruplex without disturbing the latter.

This statement was so astounding that I asked Mr. Edison if it was true.

"It was done by Henry Bently of Philadelphia," he replied. "It has also been tried with success over a wire 720 miles longs." The *Times* continues:

Mr. Edison has lately made a new and improved re- 8372
ceiver to his instrument, of which he says in a recent letter to Col. Gouraud that by its means Batchelor, one of Mr. Edison's assistants, "heard a whisper last night fifteen feet away from the receiver, and ordinary conversation comes out into the room almost as originally spoken." If this receiver proves as practicable as the carbon transmitter, a new era has opened in electric telephony, and soon we may hope to have the speeches in the House of Commons heard at all the clubs in the metropolis.

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This statement was even more astounding than the other. Mr. Edison says it is strictly true. He has one of these receivers now at work in his laboratory. Words spoken miles away are uttered within the room, and so plainly that they are distinctly heard in any part of it. A whisper is heard from fifteen to twenty feet. The great inventor says: "I think it entirely practicable for an audience miles away to hear every word uttered by Henry Ward Beecher in delivering
8374 his sermons at Plymouth Church. The debates in Congress, as well as those in the House of Commons, may also be heard by an audience anywhere."

ANOTHER REMARKABLE INVENTION.

One of the most remarkable of Mr. Edison's inventions is a stencil typewriter. He patented it in 1876, but threw it aside without improving it to begin the experiments which resulted in the discovery of the
8375 telephone. To use his own words: "I chucked it into a dark closet, after getting into the telephone business, and there it remained until the other day, when my old friend J. U. Mackenzie came in with a similiar idea in his head. I yanked the thing out of the closet, turned it over to him, and said: You want something to do. Work that up. He took it and cleared out. To-day he came back, and instead of dropping the thing as I expected, he seems to have made a perfect success of it."

8376 Mr. Edison's idea seems to have been founded on the use of needle-pointed type, but Mr. Mackenzie gives them chisel points, which is more durable and makes the stencil fully as distinct. These types are placed in a type-writer, worked with the fingers like a pianoforte. Each written page may be placed upon a Gordon press or an electric pen press, and as many copies worked off as wanted. When mistakes are made, the type may be corrected, and the lines may be

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justified or spaced out, as desired. It must prove of great value to lawyers, as they might make as many copies of their briefs or other documents as they required. By its use any man might write and print his own circulars. Small daily country newspapers might also be printed. Crude as the invention necessarily is, Mr. Mackenzie printed 148 copies of a single page on Saturday in thirty minutes. He says his chisel-pointed letters are subject to modification, but he regards the success of the stencil type-writer as assured, 8378
and there is undoubtedly a fortune in store for its inventors.

THE LATEST DISCOVERY.

After an explanation of this invention, Mr. Edison became jocose. Story followed story, and there were frequent sallies of wit and humor. As we were drawing on our overcoats preparatory to departure, the great inventor said: "I am now about to tell you "something that will astonish all electricians. I am 8379
"prepared to send a current of electricity from here "to Philadelphia without any wire."

"Why, Al." (his second name is Alva, and many of his friends call him Al.), "that's impossible," said Mackenzie, who is an old telegraph operator.

"Oh, no," answered Mr. Edison. "It can be done, and I know it. It is the result of a recent discovery."

"How?" inquired Mackenzie.

"Store it up in a condenser and send it there by express," was the reply. "Now don't give it away to any 8380
of these newspaper men."

8381

Defendant's Exhibit Sun Article of Dec. 30, 1879

THE SUN, NEW YORK, TUESDAY DECEMBER 30, 1879.

8382 ADVANCING IN TEN DAYS FROM $1,000 TO $4,800 PER SHARE OF $100.

The stock of the Edison Electric Light Company is divided into $3,000 shares, whose par value is $100 each. This makes the nominal capital $300,000. A great majority of the stock is held, it is said, by not more than ten men.

Mr. Norvin Green, President of the Western Union
Telegraph Company, is also President of the Edison
Electric Light Company. Calvin Goddard is its sec-
8383 retary, and Mr. Grosvenor P. Lowrey its counsel. The
company has bought of Mr. Edison the right to intro-
duce and continue his invention throughout the Western
hemisphere. What price he was paid has not been
made known. It is said that he has reserved half of
the right in England. The right on the European
contine t has been sold separately. Officers of the
company in New York say that Edison has been well
taken care of in the contract made with him.

The first reportable sales of the stock have been
8384 made within the past few days by Kirkland & Milli-
ker, brokers of 47 William street. Mr. E. W. Sapor-
tas, a member of that firm, says that on the day be-
fore Christmas five shares were offered at $1,350 a
share, and that on Tuesday last the firm sold two
shares at $3,000 a share and on Saturday one share at
$3,300. Since that time bids have been made as high
as $3,500, but the stock is held above that price.

Mr. Saportas says that there have been some fifty

or sixty persons in his office since Christmas to make 8385
inquiries. Those who actually bought the stock ap-
parently bought it to hold it, and not as a mere specu-
lation. One purchaser, he said, is a solid and conser-
vative merchant.

Mr. Saportas continued, "after Mr. Edison makes
his illumination at Menlo Park, the shares should go
up in value to 10,000, and that is the value at which
most of the present holders rate them now, the figures
would not be extravagant. For example in New York
city and Brooklyn alone there is $30,000,000 invested 8386
in gas stocks. Now the Edison Company would hold a
franchise not only over New York and Brooklyn, but
over all the cities and towns in North and South
America. It would be able to pay interest on the in-
creased value of the stock, which would in that case
be only $30,000,000, the same as that of the gas plant
in New York and Brooklyn. We hold only a few
shares and there are very few in the market."

Another reporter says: "Ten days ago the shares
were quoted at $1,000 each, the par value being $100; 8387
on Friday one share was sold for $2,500; on Saturday
two shares sold at $3,000, each and one for $3,300 and
yesterday one share was sold at $3,500. Five and ten
share lots are held at $4,800 and $5,000 per share."

In the Brooklyn Aldermen's meeting, yesterday, Al-
derman Smith presented a resolution for the appoint-
ment of a committee of five to go to Menlo Park to-
morrow evening to see the exhibition of the Edison
electric light, with a view of adopting it if it proves
successful. Aldermen French said that i. the light 8388
was successful the whole country would know it, and
he was opposed to any expense to the city for the
visit. He offered an amendment that the committee
should go to see the exhibition without expense to the
city. The resolution thus amended was passed.

8389

Defendant's Exhibit Barker-Morton Letter

UNIVERSITY OF PENNSYLVANIA.

PHILADELPHIA, Oct. 21st, 1878.

MY DEAR DR. MORTON:—I am glad to know by your letter received this morning that your lecture went off so well and am glad to have contributed anything to
8390 the result. The slides came home all right. Mr. Wallace told me he saw at your room a fine Jablochkoff candle lamp. Was that the one the papers spoke of as having been brought from France by Major Dresser? Can you procure the loan of it for me for my lecture of the 14th November? I only want to exhibit it.

The only wood-cuts I have on magneto-electric matters are the Gramme machine, large and small, and
8391 the Gramme ring. These of course you are quite welcome to for the purpose you mention. I think however you can borrow a better set from the Franklin Institute; the set they used to illustrate their Report on these machines. If you do get them, I would myself like the electrotypes of some of them. I applied to Johnson for electros of the cuts in my article in the Cyclopedia. But he wouldn't give me one.

That clock you speak of must be a pretty thing. Pray get one for me as soon as you can. I think they
8392 will have a good sale and you did well to order them.

Thanks for the *Tribune* with the report of your lecture. I notice you speak approvingly of Houston's new light. But did you ever think seriously of the matter? He purposes to use persistence of vision to make the light appear continuous; hence he must have at least ten flashes per second. If the duration of the flash is 1-100 of a second, there is darkness for 9-10 and light for only 1-10 the time and the average light is only 1-10 the brightness of the spark. More-

over, the time required to charge the magnets in the circuit producing the secondary spark, determines the brightness of the light. In other words, if you charge the magnet 9-10 of the time and get the light for the other 1-10 you get a light which is bright [illegible] look at by persistence, but whose illuminating power is no greater than would be that of the direct current giving light all the time. A light ten times as bright lasting only 1-10 the time is no gain over 1-10 as strong lasting the whole time. At least so it seems to me and the principle involved seems to me sufficiently absurd involving as it does a denial of the fundamental doctrine of the conservation of energy.

I think you will be surprised when Edison makes public his new light. I am not surprised, after his telephone experiences that he declines to make it public until his foreign patents are secured. He has, by an exceedingly ingenious contrivance, produced an electric burner which can in every way replace the ordinary gas burner. As you very properly say, there are many 8395
details yet to be arranged before the thing can be put in practice. The new burner, however, I know will please you.

I have been looking for you as you passed through to or from Baltimore. Stop over and see me if you have time. I expect to be in New York at the Academy meeting and shall hope to see you then.

Our regards to Mrs. Morton and love to Harry.

Cordially yours, GEORGE F. BARKER. 8396

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Defendant's Exhibit Edison-Morton Letter.

T. A. EDISON.

MENLO PARK, N. J., Oct. 10, 1878.

PROF. HENRY MORTON,

8398 Hoboken.

DEAR SIR:—Your favor of the 9th has just been received. The *Sun* article was *somewhat* exaggerated. But it is safe to say that I have some new ideas in regard to the electric light, more especially relating to the infinite subdivision of the same. I expect to put in at least 6 months solid work perfecting it. Am just ordering a 50 H. P. engine for this line of experiment.

I do not think I will enter the lecture field for seve-
8399 ral years.—Can't spare the time.—and have no inclination that way.

Very truly yours,

T. A. EDISON,

G.

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Defendant's Exhibit Telegraphic Journal Articles of October 15, 1878.

THE TELEGRAPHIC JOURNAL.

HAUGHTON & Co., LONDON, 1878.

Vol. VI., No. 137, October 15, 1878, pages 413–415. 8402

GAS V. ELECTRIC LIGHTING.

The most important practical scientific question of the hour, and the one of greatest public interest, is that of illumination by means of electricity. Every day the subject is developing and attracting more and more attention. As we predicted long ago the Paris Exposition, and the fine display of the power and beauty of the electric arc which has been this year 8403
made patent to all the world in that city, have given an incalculable impetus to the progress of this mode of lighting. It has been said, doubtless by some timid holder of gas shares with whom the wish was father to the thought, that with the Paris Exhibition so would the electric light pass away again, and sink into the darkness from whence it sprung; but there is now no fear of that. It has made too great an impression on the public mind, and gained too widespread a footing for itself in practical usage now, to lapse into obscurity. Inventors, too, are giving their ingenuity 8404
to the solution of the difficulties which still bar its advancement, a great many patents relating to it are being taken out in all civilized countries, it is one of the present tides in the affairs of men which may lead to fortune—in short "there is money in it," and its ultimate success is undoubted.

It has hitherto been the habit of gas investors to

8405 [illegible] the electri
[illegible]
[illegible] universally com
[illegible] gas companies, for [illegible]
[illegible] the superior
[illegible] of the electric light over gas light. To them
it has appeared a weird, ghastly glow, reminding them
of corpse-lights and mortal decay. If it be true that
gas directors are particularly subject to jaundiced vi-
8406 sion, a philosophic oculist might, with some show of
reason, attribute the fact to the [illegible] influence
of the yellow gas light they have been so long habitu-
ated to. From recent meetings, however, we are
happy to see that a change has taken place in the
attitude of the leading London gas companies towards
the new illuminator. It is no longer pooh-poohed by
them, but wisely regarded as a declared rival, which
must be fairly competed against if gas lighting is to
hold its ground. The cost of electric lighting for
8407 street purposes is at present so much more than gas
that, although the superiority of the light is unques-
tionable, there will be no hurry to supersede gas by
it. But even if all the streets of the metropolis were
lit by electricity, we are told that it would only cause
a reduction of about [illegible] per cent. on the gross revenues
of the companies who get their principal receipts from
domestic lighting. If this be so, there is no immedi-
ate cause for a panic among gas shares, and gas share-
holders may use the statement as a prop to their tot-
8408 tering faith. But we would advise them not to trust
too implicitly to consolation of this kind.

It is true that at present an invention, by which the
electric current supplying the electric lamps can be
subdivided so as to feed a great many light centres,
and thus at the same time moderate while it distributes
the light, is a desideratum necessary to the complete
success of electric lighting even for general street pur-
poses, let alone household uses. But tried inventors

are at work on the problem, and any day may see its 8409
accomplishment. Some comfort may be derived
from reflections that gas lighting will never be driven
from the field, that gas will be more and more used
for heating purposes, that it will even be used in gas
engines for generating powerful electric lights, and that
at least for many years to come it will keep its im-
pregnable position as a domestic illuminator. But at
the same time it should not be forgotten that an in-
vention may come any day which will dispel these
dreams of security, and banish gas lighting to a second- 8410
ary place. In proof of this we have only to cite the
report from America (published on another page) that
the indefatigable Mr. Edison has succeeded in solving
the problem of general electric illumination in the most
thorough and sweeping manner. While the gas com-
panies were in the act of laying the soothing unction to
their souls, and congratulating themselves on their safe
position even against street lighting, the news was be-
ing flashed across the Atlantic that Edison had invent-
ed a means of subdividing the electric current indefi- 8411
nitely, so as to produce 1,000 lights if need be from
one machine, and of bringing it into homes for house-
hold purposes, such as lighting, heating, and driving
sewing machines, at half the cost of gas and without
disturbing the existing brackets and chandeliers.

The Napoleon of invention delights in startling sur-
prises, and his fertile and daring imagination runs at
once through the whole gamut of possibilities as soon
as the key-note of a new idea is struck. Future de-
velopments are to him as if they already existed; but 8412
for all that the great mechanical genius of Mr. Edison
is so well attested, that any report of the kind is to be
taken seriously. It is a sign of the uncanny reputation
of this inventor, that on the publication of the said
announcement in London on October 8th, the gas
shares fell seven per cent. No opinion can be passed
on the merits of the new invention until a description

8413 of it is made public, which will not be until the patents are secured. Meanwhile, both inventors, gas shareholders, and the general public will be interested to learn what the coming disclosure is to be. We trust that Mr. Edison, for his own as well as others, sake, has make himself certain of the success of his invention before sending forth the telegrams proclaiming it. It is a fine thing, no doubt, to assume the god and shake the spheres with a nod; but it must not be for-
8414 gotten that the disturbance may cost heavily to humbler beings. In conclusion, we would remark that the announcement that the problem of dividing the light has been completely solved by Mr. Edison need not deter other inventors from giving their minds to this matter. We have yet to learn what the new system is, and although Mr. Edison is admittedly a great inventor, he cannot be supposed to monopolize all ideas on the subject, nor even always to hit upon the best.

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EDISON'S ELECTRIC LIGHT.

Information reached this country on Monday, October 7, stating that Mr. Edison, the inventor of the phonograph, had succeeded in dividing the electric light, so as to apply it to the existing gas fixtures, at a considerable reduction in cost. The same communication was made to the American Commissioners at the Paris Exhibition, and through them made known
8416 in London. On the news of this discovery becoming known, a heavy fall in the value of gas shares took place. The following description of Mr. Edison's invention is taken from the *New York Sun*:

"Mr. Edison says that he has discovered how to make electricity a cheap and practicable substitute for illuminating gas. Many scientific men have worked assiduously in that direction, but with little success.

A powerful electric light was the result of these experiments, but the problem of its division into many small lights was a puzzler. Gramme, Siemens, Brush, Wallace, and others produced at most ten lights from a single machine, but a single one of them was found to be impracticable for lighting aught save large foundries, mills, and workshops. It has been reserved for Mr. Edison to solve the difficult problem desired. This, he says, he has done within a few days. His experience with the telephone, however, has taught him 8418
to be cautious, and he is exerting himself to protect the new scientific marvel, which, he says, will make the use of gas for illumination a thing of the past. While on a visit to William Wallace, the electrical machine manufacturer in Ansonia, Connecticut, he was shown the lately perfected dynamo-electric machine for transmitting power by electricity. When power is applied to this machine it will not only reproduce it, but will turn it into light. Although said by Edison to be more powerful than any other machine of 8419
the kind known, it will divide the light of the electricity produced into but ten separate lights. These being equal in power to 4,000 candles, their impracticability for general purposes is apparent. Each of these lights is in a substantial metal frame, capable of holding in a horizontal position two carbon plates, each 12 inches long, 2½ inches wide, and ½ inch thich. The upper and lower parts of the frame are insulated from each other and one of the conducting wires is connected with each carbon. In the centre, and above the upper carbon, 8420
is an electro-magnet in the circuit, with an armature, by means of which the upper carbon is separated from the lower as far as desired. Wires from the source of electricity are placed in the binding posts. The carbons being together, the circuit is closed, the electro-magnet acts, raising and lowering the upper carbon enough to give a bright light. The light moves

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towards the opposite end from which it starts, then
changes and goes back, always moving towards the
place where the carbons are nearest together. If from
any cause the light goes out, the circuit is broken, and
the electric magnet ceases to act. Instantly the upper
magnet falls, the circuit is closed, it relights, and sep-
arates the carbon again. Edison, on returning home
after his visit to Ansonia, studied and experimented
8422 with electric lights. On Friday, October 4, his efforts
were crowned with success, and the project that has
filled the minds of many scientific men for many years
was developed. "I have it now!" he said, on Satur-
day, while vigorously turning the handle of a Ritchie
inductive coil in his laboratory at Menlo Park, "and,
singularly enough I have obtained it through an entire-
ly different process than that from which scientific men
have ever sought to secure it. They have all been work-
ing in the same groove, and when it is known how I have
8423 accomplished my object, everybody will wonder why
they have never thought of it, it is so simple. When ten
lights have been produced by a single electric machine,
it has been thought to be a great triumph of scientific
skill. With the process I have just discovered I can
produce 1,000 aye, 10,000 from one machine. Indeed,
the number may be said to be infinite. When the
brilliancy and cheapness of the lights are made known
to the public—which will be in a few weeks, or just as
soon as I can thoroughly protect the process—illum-
8424 ination by carruburetted hydrogen gas will be dis-
carded. With 15 or 20 of these dynamo-electric ma-
chines recently perfected by Mr. Wallace I can light
the entire lower part of New York City, using a 500-
horse power engine. I propose to establish one of
these light centres in Nassau street, whence wires can
be run up town as far as the Cooper Institute, down to
the battery and across to both rivers. These wires
must be insulated, and laid in the ground in the same

8425

manner as gas pipes. I also propose to utilize the
gas burners and chandeleirs now in use. In each house
I can place a light meter, whence these wires will pass
through the house, tapping small metallic contrivances
that may be placed over each burner. Then house-
keepers may turn off their gas and send the meters
back to the companies from whence they came. When-
ever it is desired to light a jet it will only be necessary
to touch a little spring near it. No matches are re-
quired. Again the same wire that brings the light to 8426
you,' Mr. Edison continued, 'will also bring power
and heat. With the power you can run an elevator, a
sewing machine, or any mechanical contrivance that
requires a motor, and by means of the heat you may
cook your food. To utilize the heat it will only be
necessary to have the ovens or stoves properly ar-
ranged for its reception. This can be done at trifling
cost. The dynamo-electric machine, called a telema-
chon, and which has already been described, may be 8427
run by water or steam power at a distance. When
used in a large city the machine would of necessity be
run by steam power. I have computed the relative
cost of the light, power, and heat generated by the
electricity transmitted to the telemachon to be but a
fraction of the cost where obtained in the ordinary
way. By a battery or steam power it is 46 times
cheaper, and by water power probably 95 per cent
cheaper.' It has been computed that by Edison's process
the same amount of light that is given by 1,000 cubic
feet of the carburetted hydrogen gas now used in this 8428
way, and for which from $2.60 to $3.00 is paid, may be
obtained for from 12 to 15 cents. Edison will soon
give a public exhibition of his new invention."

8429

Defendant's Exhibit Wilde's Report on the Ladyguine Lamp.

Les Mondes, 1875, Vol. 36, page 183.

NOUNEAU MODE DE SUMIERE ELECTRIQUE.

8430 *Rapport de M. le Dr. Wilde, membre de l'Académie des sciences et directeur de l'Observatoire physique central, sur la découverte de M. Ladyguine.* (Extrait du *Journal de Saint-Pétersbourg* du 11 Janvier 1875. Communiqué par le *Solitaire de Seyménie.*)

Depuis que Davy a découvert, en 1821, l'arc galvanique lumineux, on a fait maintes applications pratiques de cette source de lumière artificielle, la plus éclatante de toutes. Mais en même temps se sont manifestés aussi de plus en plus nettement les incon-
8431 vénientes dont elle est entachée. Malgré les régulateurs compliqués que l'on a imaginés pour faire avancer les electrodes de charbon au fur et a mesure qu'ils se consument, la lumière électrique n'en restait pas moins toujours inconstants et variant rapidement d'intensité. Quant à son emploi dans la vie usuelle, cette lumière était par trop vive sur un seul point, et il paraissait impossible de la diviser en un grand nombre de points lumineux moins intenses. De plus, sa production au moyen des batteries galvaniques
8432 ordinaires était trop compliquée et trop coûteuse.

Mais depuis que l on est parvenu tout récemment, par l'emploi de machines électro-magnétiques mues à la vapeur, a engendrer a moins de frais et avec plus de facilité un courant électrique, et, par suite, à obtenir une lumière électrique au charbon qui, à intensité égale, coûtait trois fois moins que le gaz d'éclairage, on a redoublé d'fforts pour rendre la lumière électrique plus constante et pour la diviser a volonté en points lumineux d'une moindre intensité.

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On a fait dans ce but maints essais infructueux; ainsi, on a proposé pour la division de la lumière électrique l'emploi de la lumière des tubes dits de Geissler, mais l'expérience a montré que cette lumière était trop faible et trop peu constante.

Il était réservé a M. Ladyguine de résoudre ces deux problèmes de la manière la plus simple, et de rendre possible un usage général de la lumière électrique, progès qui est de nature à réaliser un évolution complète et de la plus grande utilité dans la question 8434
de l'éclairage.

Il est depuis longtemps connu que la lumière électrique au charbon n'est pas due à un effet lumineux direct du courant électrique, mais seulement a la propriété de ce courant d'échauffer les conducteurs qu'il traverse, et cela avec d'autant plus d'intensité que ces conducteurs opposent plus de résistance au courant. La vive intensité de la lumière électrique ordinaire, au charbon, est due, par consequent, à la circonstance que la couche d'air, mauvais conducteur, qui se trouve entre les deux pointes des charbon, s'échauffe a un 8435
degré excessivement élevé par le passage du courant électrique, et produit indirectement la combustion des électrodes de charbon, chauffés à blanc. Cette lumière ne peut cependant être que très intense parce que seul un tres fort courant est capable de vaincre la grande résistance de la couche d'air.

On savait aussi depuis longtemps que l'on peut employer la faculté échauffante du courant électrique, meme sans l'aide d'un gaz, comme dans l'arc gal- 8436
vanique lumineux, pour chauffer à blanc un corps solide. Se basant sur ce principe, on a souvent chauffé ainsi des fils de platine minces, donc mauvais conducteurs, en les faisant traverser par un fort courant électrique. La lumière obtenue par ce procédé est beaucoup plus fixe et plus constante que la lumière électrique au charbon; elle a aussi plus de force d'extension, et peut être augmentée ou dimi-

8437 nuée a volonté; néanmoins, elle n'a jamais trouvé un emploi pratique, parce qu'elle est trop faible eu comparaison de son prix de revient, et parce qu'en voulant lui donner plus d'intensité, on aboutit facilement a faire fondre le platine, qui, en général, n'est pas tout à fait homogène.

C'est M. Ladyguine qui le premier a eu l'idée de remplacer, dans ces experiences d'ignition, le fil de platine par de minces tiges d'un charbon (coke ou
8438 charbon de cornue) analogue au graphite, c'est-à-dire bon conducteur, et par là il a résolu le problème de l'éclairage électrique.

Les avantages de cette substitution du charbon au platine sautent tellement aux yeux aussi au point de vue théorique, que l'on est tout etonné,—comme cela est d'ailleurs le cas pour beaucoup d'importantes inventions,—de ce qu'on n'en a pas eu l'idée plus tôt. Le charbon possède, a température égale, un beaucoup plus grand pouvoir de rayonnement que le platine; la
8439 capacité calorique du platine est supérieure presque du double à celle du charbon, qui est en outre bon conducteur, de sorte que la même quantité de calorique élève la température d'une petite tige de ce charbon a un degré presque deux fois plus élevé qu'elle ne le fais pour un fil de platine du même volume. En outre, la résistance du charbon en question comme conducteur d'électricité est environ 250 fois plus grande que celle du platine; il en résulte que la petite tige de charbon peut être 15 foit plus épaisse
8440 qu'une tige de platine de la même longueur sans que le courant qui la traverse cesse d'engendrer la même quantité de chaleur. Enfin le charbon peut être chauffé à blanc jusqu'au degré le plus extrême sans qu'on ait en redouter la fusion, comme c'est le cas pour le platine. C'est a ces importants avantages théoriques que l'on doit évidemment le grand succes pratique déjà démontré du mode d'éclairage électrique de M. Ladyguine.

Le seul inconvénient de l'emploi du charbon au lieu 8441
du platine consiste en ce que, dans l'ignition, le charbon se combine avec l'oxygène de l'air et se consume ainsi peu a peu. Mais M. Ladyguine a déjà paré a cet inconvénient en enfermant le charbon chauffe à blanc par le courant électrique dans un récipient en verre hermetiquement clos, et de l'intérieur duquel l'oxygène est expulsé par un procédé des plus simples.

Il n'appartient d'ailleurs pas a l'Académie des sciences de donner son jugement, ni d'un côté, sur ces 8442
difficultés techniques et d'autres encore qui se présenteront dans l'application en grand de l'invention de M. Ladyguine, ni, d'un autre côte, sur les nombreux avantages pratiques de ce mode d'éclairage comparativement á tous les autres; il suffira a l'Académie d'avoir constaté que, grace à cette invention, se trouve résolu de la manière la plus simple possible le grand problème de diviser la lumière électrique et de la rendre constante, pour reconnaitre M. Ladyguine, en considération des nombreuses applications utiles de 8443
son invention, digne d'obtenir le prix Lomonossow.

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8445

Translation.

A New Method of Electric Lighting.

Report of Dr. Wilde, member of the Academy of Sciences and director of the Central Observatory of Physics, upon the discovery of Mr. Ladyguine.
8446 (Extract from the *Journal de Saint-Pétersbourg* of the 11th of January, 1875. Communicated by le Solitaire de Seyménie).

Since Davy discovered in 1821 the luminous galvanic arc, many practical applications have been made of this source of artificial light, the most brilliant of all. But at the same time the inconveniences with which it is surrounded have also become more and more clearly apparent. In spite of the complicated regulators which have been invented for feeding forward the
8447 carbon electrodes, as they are consumed, the electric light does not on that account remain less unsteady and rapidly varying in intensity. As to its employment in the usual way, this light was a good deal too strong in one single point, and it seemed impossible to divide it into a great number of luminous points of less intensity. Moreover its production by means of the ordinary galvanic apparatus was too complicated and expensive.

But since we have quite recently reached the point
8448 by the employment of electro-magnetic machines driven by steam, of generating an electric current at less cost and with greater facility, and consequently of obtaining an electric light with carbon which, for equal intensity, costs three times less than illuminating gas, attempts have been redoubled to render the electric light more steady, and to divide it at will into luminous points of a less intensity.

To this end many fruitless efforts have been made: 8449
thus, the employment of the light of the tubes called Geissler-tubes has been proposed for the division of the electric light, but experience has shown that this light was too feeble and not constant enough.

It was reserved for Mr. Ladyguine to solve these two problems in the most simple manner and to render possible a general use of the electric light,—a progress which is of the nature of a complete evolution, and one of the greatest utility in the question of lighting. 8450

It has for a long time been known that the carbon electric light is not due to a direct luminous effect of the electric current, but only to the property of this current of heating the conductors which it traverses, and that with the more intensity as the conductors oppose more resistance to the current. The vivid intensity of the ordinary electric light with carbon is due consequently to the circumstance that the layer of air, a bad conductor, which is found between the two points of the carbon, is heated to an excessively high 8451
degree by the passage of the electric current, and produces indirectly the combustion of the carbon electrodes which are heated to whiteness. This light nevertheless cannot but be very intense, because only a very strong current is capable of overcoming the great resistance of the layer of air. It has been known also for a long time that the heating property of an electric current can be employed even without the aid of the gas, as in the luminous galvanic arc, to heat to whiteness a solid body. In accordance with this prin- 8452
ciple, thin platinum wires, which are bad conductors, have often been heated by causing them to be traversed by a strong electric current. The light obtained by this process is a good deal more fixed and more constant than the carbon electric light. It has also more power of diffusion, and can be increased or diminished at will. Nevertheless it has never found a practical use, because it is too feeble in comparison with its cost

8453 of production, and because in attempting to give it more intensity the result is usually reached of melting the platinum, which generally is not altogether homogeneous.

It was Mr. Ladyguine who first conceived the idea of replacing the platinum wire in these experiments in ignition by thin rods of a carbon (coke or gas-retort carbon) analogous to graphite, that is to say, a good conductor, and in that way he has solved the problem
8454 of electric lighting.

The advantages of this substitution of carbon for platinum are so evident from the theoretical point of view, that we are altogether astonished, as is moreover often the case with a great many important inventions, that nobody conceived the idea earlier. Carbon possesses, at an equal temperature, a good deal greater radiating power than platinum; the calorific capacity of platinum is superior, almost double, to that of carbon, which is moreover a good conductor, so that the same quantity of heat raises the temperature of a small
8455 rod of carbon to a degree almost twice higher than it does for a wire of platinum of the same volume. Moreover the resistance of the carbon in question as a conductor of electricity is about 250 times greater than that of platinum; from which it results that the small rod of carbon can be fifteen times thicker than a rod of platinum of the same length, without having the current which traverses it cease to generate the same quantity of heat. Finally, carbon can be heated to whiteness
8456 even to the most extreme degree without apprehension of its fusion, as is the case with platinum. It is to these important theoretical advantages that is due the great practical success, already demonstrated, of Mr. Ladyguine's method of electric lighting.

The only inconvenience of the employment of carbon in the place of platinum consists in this, that when ignited the carbon combines with the oxygen of the

air, and thus is consumed little by little. But Mr. 8457
Ladyguine has already overcome this inconvenience by enclosing the carbon heated to whiteness by the electric current in a receptacle of glass hermetically closed and from the interior of which the oxygen has been expelled by a very simple process.

It does not appertain, however, to the Academy of Sciences to give its judgment, either on the one hand, upon the technical and other difficulties still which
are presented in the application on a large scale of the 8458
invention of Mr. Ladyguine, nor on the other hand, upon the numerous practical advantages of this mode of lighting as compared with all others. It will suffice for the Academy to have stated that by reason of this invention, the great problem of dividing the electric light and rendering it constant, has been solved in the most simple manner possible, and to recognize Mr. Ladyguine, in consideration of the numerous useful applications of his invention, as worthy to receive the
Lomonossow prize. 8459

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Defendant's Exhibit Extract from Fontaine's Electric Lighting.

ELECTRIC LIGHTING.

A PRACTICAL TREATISE,

BY HIPPOLYTE FONTAINE.

8462 *Translated from the French by Paget Higgs.*

London.

E. & F. N. Spon, 1878.

Pages 38 to 52.

CHAPTER III.

ELECTRIC CARBONS.

Wood Carbon Rods—Retort Carbon—Its Inconveniences—Staite and Edwards' Carbons—Le Molt's Carbons—Lacassagne and
8463 Thier's Carbons—Carmer's Carbons—Jacquelain's Carbons—Peyret's Carbons—Archereau's Carbons—Carré's Experiments—His Processes of Manufacture—Gaudoin's Experiments—His Processes of Manufacture—Comparative Trials of several kinds of Carbons.

In his experiments on the voltaic arc, Davy made use of rods of wood carbon extinguished in water or mercury. These rods burnt with great brilliancy, and in a very regular manner, but they wore away so rapidly
8464 that their use was obliged to be reserved for laboratory experiments. In replacing the wood carbon by the deposits collected from the walls of gas retorts, Foucault really opened up to the voltaic arc the epoch of useful applications. Retort carbon is, in fact, much more dense, and resists for a long time the destructive action of the voltaic focus.

But, as M. Le Roux has observed with reason, the last word has not been said upon this question, and

retort carbon will still offer grave inconveniences. Its 8465
density is far from uniform, it sometimes splits, frequently works irregularly, and produces considerable variations in brilliancy. These variations chiefly depend upon the presence of foreign matters, such as alkaline or earthy salts, and also notable quantities of silica. These matters are much less refractory than the carbon; they pass into vapor, and form for a great part the flame which envelopes the arc. This flame is more conducting than the voltaic arc proper; moreover, as it has a much greater section, it is less heated. 8466
and besides, as it is a gaseous body, its power of radiation is less than that of the particles of carbon which constitute the arc.

Let us hasten to say that, by suitably choosing the two rods which should furnish a regulator, retort carbon gives satisfactory results in most of its applications.

When the voltaic arc is enclosed in a globe of frosted glass, the scintillations, intermittences, and variations in the intensity of the focus are much less 8467
felt; the shadows are much less marked, the light is softer, more homogeneous, more agreeable. But the globe causes a very considerable loss of light, and whenever the small irregularities, due to the imperfection of the carbon, are supportable, the carbons should be burned without a globe. Moreover, one gets readily accustomed to the electric light; and the workmen now, instead of complaining, seek factories lighted in this manner.

Several inventors have endeavored to substitute for 8468
carbons cut directly from the deposits on the walls of retorts, similar agglomerates, but purer; others have merely purified retort carbons. Some have obtained products very remarkable in respect of luminosity, but

8469 practically inapplicable on account of their extreme cost.

Among the processes proposed for the improvement of electric carbons, we will cite those of Messrs. Staite and Edwards, Le Molt, Lacassagne and Thiers, Curmer, Jacquelain, Peyret, Archereau, Carré and Gaudoin.

8470 STAITE AND EDWARDS' CARBON.

In 1846, Messrs. Staite and Edwards patented a process for the manufacture of carbons for the electric light, which had for its base a mixture of pulverized coke and sugar.

The coke is first reduced to a nearly impalpable powder, and a small quantity of syrup added, the mixture being purged, moulded, and strongly compressed. Then the carbon is subjected to a first heating, and plunged into a very concentrated solution of sugar,
8471 and again subjected to a white heat.

LE MOLT'S CARBON.

M. Le Molt, in 1849, patented a composition for electric carbons, consisting of two parts of retort carbon, two parts of wood—charcoal or of coke, and one part of tar. The substances were in the first place
8472 pulverized, pounded, mixed, and by much trituration brought to the state of a stiff paste; then, by the aid of powerful mechanical means, subjected to great compression.

The moulded pieces were covered with a coating of syrup, and placed beside each other in a vessel of retort carbon. They were then subjected to a high temperature for a period of from twenty to thirty hours and purified, if necessary, by immersion in acids.

LACASSAGNE AND THIERS' CARBON. 3473

In 1875, Messrs. Lacassage and Thiers gave attention to the purification of retort carbons. They fused a certain quantity of caustic potash or soda. When this bath was at a red heat, they digested in it, for about a quarter of an hour, the carbon rods which had been previously cut from the walls of retorts.

This operation was intended to change into a soluble silicate of potash or soda, the silica contained in
the carbons, which is so pernicious to the constancy of 8474
the light. The carbon rods were then washed in boiling water, and subjected for several hours (in a red-hot tube of porcelain or fire-clay) to the action of a current of chlorine, which had the effect of converting the different earthy matters that the alkali had not attacked, into volatile chlorides, as of silica, calcium, potassium, iron, &c. Thus cleansed, these carbons gave a somewhat more regular light.

CURMER'S CARBON. 8475

Curmer's process consists principally in the calcination of lamp-black, benzine, and oil of turpentine, the whole mixed and moulded in the form of cylinders; the decomposition of these substances leaves a porous carbon, which is soaked with resins or saccharine matters and again calcined. By repeating these operations, M. Curmer succeeded in producing carbons of small density, or conducting power, certainly, but extremely regular and free from all impurities. 8476

JACQUELAIN'S CARBON.

M. Jacquelain, late chemist at l'Ecole Centrale, has endeavored to imitate the circumstances which, during the manufacture of gas, give birth to retort carbon. These circumstances are the coming into contact with the white-hot walls of the retort of very dense hydro-carburetted matters, of which part is volatilized and

8477 the rest decomposed, leaving as residue a layer of carbon. In the retorts used in the manufacture of gas, these hydro-carburetted matters carry away with them a great number of the impurities that the coal contains. By taking the tars resulting from true distillation, cleared consequently of all the non-volatile impurities, and realizing, in special apparatus, these conditions of decomposition in contact with highly-heated walls, retort carbons ought to be reproduced possessing perfect purity. It is this that M. Jacquelain has done in
8478 operating with a tube of refractory earth 0·15 metre diameter, in an improvised furnace; and he has obtained some plates which, cut into rods with a saw, have given a light perfectly steady, whiter, and of about 25 per cent. greater intensity, with an equal electric current, than that given by the ordinary carbons.

The experiments made with these carbons, by the Paris Administration of Lighthouses, have been so conclusive that we had, about the commencement of 1876, the idea of putting the process in practice. But
8479 M. Jacquelain, being consulted, explained to us that it was impossible to calculate: 1st, the expenditure necessary for the establishment of a continuous manufacture; 2nd, the approximate net cost price of the carbons obtained. As another process by M. Gaudoin has commenced to give good results, we have not continued our idea. We have long ago learnt what is the cost of converting a very exact laboratory process into an industrial operation, and we do not wish to launch into an affair of this nature without some figures
8480 being given.

The carbon of M. Jacquelain, once formed, has always the inconvenience of requiring a considerable amount of manual labor before use can be made of it (because the material is so hard, that it can with difficulty be cut by the saw), and of producing relatively considerable waste.

PEYRET'S CARBON. 8481

M. Peyret, a physicist of Lourdes, has prepared carbons by soaking pieces of elder-tree pith or any other porous body with liquefied sugar, and afterwards decomposing the sugar by heat. By repeating the operation a sufficient number of times, he obtained very dense carbons, which he then submitted to a current of sulphide of carbon.

We have had in our hands only very small fragments of these carbons, and it has been impossible for us to 8482
give an estimate of their worth; their high price is in every case a very serious obstacle to the development of an industrial manufacture.

ARCHEREAU'S CARBON.

M. Archereau, whose name frequently comes under the pen in questions relating to agglomerates of carbon, or to electricity, has presented to the Academy of Sciences some new rods for electric regulators, composed of carbon mixed with magnesia, agglomerated 8483
and pressed; the magnesia has, according to the author, the advantage of making the light more steady and of augmenting its lighting power.

We have tried several samples of these carbons; some were of good quality, others inferior to retort carbons. Several carbons furnished a light of 150 burners, with a total consumption per hour of 0·03 metre. It is a manufacture that is capable of giving good results, but needs very careful revision.
8484

CARRÉ'S CARBON.

M. Carré has made a great number of experiments for the electric light upon retort carbons impregnated with different salts, and has combined a new product for the same usage. Some details of his labors are necessary to make their importance and merit understood.

8485 By impregnating porous carbons, and by a prolonged ebullition in concentrated solutions, M. Carré proves.

1st. That potash and soda at least double the length of the voltaic arc, render it more silent, combine themselves with the silica, and eliminate it from the carbons by making it flow to six or seven millimetres from the points, in a state of vitreous globules, limpid and often colorless; that these substances augment the light in the proportion of 1—25 to 1.

2nd. That lime, magnesia, and strontia augment the
8486 light in the proportion of 1-40 to 1, by the coloring
in different ways.

3rd. That iron and antimony carry the augmentation to 1-60 or 1-70.

4th. That boracic acid augments the duration of the carbons by enveloping them with a vitreous layer which isolates the oxygen from them, but without augmenting the light;

5th. That upon the whole the impregnation of pure
and regular porous carbons, with the solutions of dif-
8487 ferent substances, is a convenient and economical
means of producing their spectra, but that the mixing of the simple substances with the carbon compound is preferable.

For the manufacture of carbons, M. Carré recommends a composition of powdered coke, calcined lamp-black, and a special syrup formed of 30 parts of cane-sugar and 12 parts of gum.

The following formula is recommended in the patent of the 15th January, 1876:

8488 Coke, very pure, in fine, nearly impalpable, powder,	15 parts
Calcined lamp-black,	5 "
Special syrup	7 to 8 "

The whole is strongly triturated, and has added to it from 1 to 3 parts of water, to compensate for the

loss by evaporation, according to the degree of tough- 8489
ness to be given to the paste. The coke ought to be made with the best coals, pulverized and purified by washings. (The coal powder may be likewise purified by washings by decantation and maceration with heat in acid baths.) The coke dust of gas retorts is generally pure enough.

The paste is now pressed and passed through a draw-plate, then the carbons are placed in tiers in crucibles,
and are subjected during a given time to a high temp-
erature. 8490

The cooking comprehends a series of operations.

For the first, the carbons are placed horizontally in the crucible, resting upon a bed of coke dust; every layer is separated by a cover of paper to avoid any adherence. Between the last layer and the cover is put one centimetre of coke-sand, and one centimetre of silicous sand upon the joint of the cover.

After the first operation, which ought to last from
four to five hours, and attain a cherry-red heat, the car-
bons should remain two or three hours in a very con- 8491
centrated and boiling syrup of cane-sugar or caramel, with two or three intervals of considerable cooling, in order that the atmospheric pressure may force the syrup into all the pores. The carbons are then left to drain by opening a cock placed at the bottom of the vessel, after which they are agitated for some instants in boiling water to dissolve the sugar remaining on the surface.

After dessication the carbons are submitted to a sec- 8492
ond cooking to the degree required; they are then stood up in the crucible by filling up their interstices with sand.

They are thus manipulated from stage to stage, until they have acquired the density and solidity requisite, and the manipulation is facilitated by the use of an oven having as many stages as there are cookings required.

8493 The carbons are dried slowly. Their dessication is completed in a stove, the temperature of which attains gradually 80 degrees in twelve or fifteen hours. To prevent their becoming deformed in drying, the rods are placed on pieces of sheet iron having a V-form.

The Carré carbons are more tenacious and are harder than those of retort carbon. They are remarkably accurate and regular. Rods of 0.01 metre diameter
8494 and of 0.05 metre length can be employed without fear of rupture. Their cylindrical form and their homogeneity make the cones maintain as perfect shape as if they were turned. They are also better conductors than retort carbons. The only inconvenience that we have remarked in their employment is a rapid disaggregation, the production of small sparks, and irregularity of the luminous brilliancy.

GAUDOIN'S CARBONS.

8495 M. Gaudoin also has made numerous experiments upon carbons containing foreign substances.

The following bodies have been introduced into the carbons:

1st, phosphate of lime from bones; 2d, chloride of calcium; 3d, borate of lime; 4th, silicate of lime; 5th, pure precipitated silica; 6th, magnesia; 7th, borate of magnesia; 8th, phosphate of magnesia; 9th, alumina; 10th, silicate of alumina.

8496 The proportions were calculated in such a manner as to obtain five per cent. of oxide after the cooking of the carbons. These were submitted to the action of an electric current, always of the same direction, furnished by a Gramme machine powerful enough to maintain a voltaic arc of 10 to 15 Millimètres in length.

The negative carbon being placed at the bottom, M. Gaudoin has observed the following results:

1st. The complete decomposition of the phosphate of lime under triple influence of electrolytic action, 8497
calorific action, and reducing action of the carbon. The reduced calcium goes to the negative carbon, and burns in contact with the air with a reddish flame. The lime and phosphoric acid are diffused into the air, producing abundant fumes. The light, measured by a photometer, is double that which is produced by carbons of the same section cut from the residue of gas retorts.

8498

2d. Chloride of calcium, borate and silicate of lime are also decomposed, but the boracic and silicic acids appear to escape, by volatilization, from the electric action. These bodies give less light than the phosphate of lime.

3d. Silica introduced into the less conducting carbons, melts and volatilizes without being decomposed.

8499

4th. Magnesia, borate and phosphate of magnesia are decomposed; the magnesium in vapor goes to the negative carbon and burns, in contact with the air, with a white flame. The magnesia, boracic and phosphoric acids diffuse into the air in a state of vapor. The increase of light is less considerable than with the lime salts.

5th. Alumina and silicate of alumina are decomposed only with a very strong current and a very considerable voltaic arc, but under these circumstances the de- 8500
composition of the alumina is well manifested, and the alumina in vapor, is seen to go off from the negative pole like a jet of gas, and burn with a blue flame of little lighting power.

The flame and vapor which constantly accompany these electro-chemical lights having appeared to him a great obstacle to their utilization for illumination, M. Gaudoin has not pushed these experiments further.

8501 He has preferred to follow up his studies upon the agglomeration of carbon.

The products manufactured by M. Gaudoin being superior to all others, we will expatiate a little upon this mode of manufacture.

The patent is dated 12th July, 1876.

As we have said above, the carbons intended for the production of the voltaic arc ought to be chemically pure. Thus, the dust of retort carbon, though
8502 containing only a small proportion of foreign matters, is not sufficiently pure for this use, and its employment presents some inconveniences. The washings in acids or alkalies to which the carbonaceous matters may be submitted, with the aim of extracting the impurities they contain, are costly and insufficient. Lamp-black is pure enough, but its price is high and its management difficult. Owing to this, M. Gaudoin had to seek elsewhere a better source of carbon, and
8503 he has found a solution of the problem in decomposing, by heat in closed vessels, the dried pitches, fats or liquids, the tars, resins, bitumens, natural or artificial essences or oils, organic matters capable of leaving behind carbon sufficiently pure after their decomposition by heat.

The apparatus employed to effect this decomposition are closed retorts or crucibles of plumbago. These crucibles are placed in a furnace capable of being heated to a bright red. The lower parts of the crucibles are furnished with two tubes, serving, one for
8504 the disengagement of gas and volatile matters, the other for the introduction of the primary material. The volatile products of decomposition may be conducted under the hearth of the furnace and there burnt for heating the crucibles, but it is more advantageous to conduct them into a condensing chamber or into a copper still, and to recover, after condensation, the tars, oils, essences, and hydro-carbons that are produced in this operation.

M. Gaudoin utilizes these different sub-products 8505
also in the manufacture of his carbons; he takes great care to avoid for the worms and receivers the use of iron, zinc, or any substances susceptible of being attacked by these tars, because the whole value rests in purity.

Whatever may be the primary material employed for the manufacture of this carbon, the decomposition by heat should be able to be conducted either slowly or quickly, according to the nature of the sub-products 8506
that it is proposed to obtain. For operating slowly it suffices to two-thirds fill the retort and to heat gradually up to a clear red, avoiding as much as possible the boiling over of the substances. For operating quickly, the empty retort is heated to a deep red, and the primary material thrown into the bottom in small quantities, in a thin stream if it is liquid, and in small fragments if it is solid. The slow distillation gives most tars and heavy oils and little gas. The quick decomposition gives more light oils and gas. 8507

When the primary material has been properly chosen, there remains in the retort, carbon more or less compact. It is pulverized as finely as possible, and agglomerated alone or with a certain quantity of lamp-black by means of the carbides of hydrogen obtained as secondary products.

Thus prepared, those carbides are completely free from iron, and are much preferable to those found in commerce, not only in the agglomeration of the carbon,
but also in the impregnation or soaking of the manufactured objects. (The last operation, by filling up 8508
the pores, introduces oxide of iron when effected with commercial products.)

The objects made in agglomerated carbon are, for one variety of carbon, as much more combustible as they are porous, and as much more porous as they are moulded with less pressure. The inventor himself uses for his manufacture, steel moulds capable of resisting the highest pressure of a strong hydraulic press.

8509 Although the draw-plate or moulding apparatus, used long since in the manufacture of ordinary graphite carbons, may be used, without any modification, for the manufacture of carbons for the electric lamp, M. Gaudoin has added to this apparatus certain important improvements. Thus, instead of causing the carbons to issue, from top to bottom, vertically, he places the orifice or orifices of the mould upon the side, and in such a manner that the issuing carbons form with the horizon a descending angle of 20 to 70 degrees. This
8510 arrangement allows of emptying the whole of the matter contained in the mould without interrupting the work, and as the carbon is constantly supported it does not break under its own weight, which frequently happens when issuing vertically.

We have made, at different times, numerous trials with all kinds of carbons, and those of M. Gaudoin's manufacture gave the best results. It has necessitated much time and considerable expense to remove this manufacture from the merely scientific domain to
8511 that of the practical, but success has crowned the efforts of the inventor. (Table A.)

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TABLE A. 8515

TABLE OF EXPERIMENTS MADE WITH SEVERAL ELECTRIC CARBONS, 6th November, 1876.

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Name of Carbon.	Dimensions.	Speed of Machine.	Consumption — Of negative Carb.	Of positive Carb.	Total per Hour.	Mean of two experiments.	Regularity.	Observation.
			m.m.	m.m.	m.m.	m.m.		
Retort	9 m.m. square.	600	19	36	55		Irregular.	
"	9 m.m. square.	920	23	48	71	63	Sufficiently regular.	Scintillating, eclipsed for a short time, a slight disaggregation.
Archereau	10 m.m. diam.	800	20	60	80		Sufficiently regular.	
"	10 m.m. diam.	920	30	60	90	85	Sufficiently regular.	A slight disaggregation; a few sparks. Cinders of Oxide of Iron in rather large quantity. White light. Cones good.
Carré. ...	10.4 m.m. diam.	800	18	60	78		Irregular.	
"	10.4 m.m. diam.	920	26	80	106	92	Regular enough.	A slight disaggregation; a few sparks. More cinders than the preceding; reddened for a greater length.
Gaudoin.	11.3 m.m. diam.	800	20	38	58		Very regular.	
"	11.3 m.m. diam.	920	38	50	88	73	Very regular.	Neither disaggregation nor sparks; less cinders than the Carré and Archereau carbons

8517 The light produced with the retort carbons was equal to 103 burners, and that produced by the artificial carbons varied between 120 and 180 burners for the Archereau and Carré carbons, and between 200 and 210 for the Gaudoin carbons. The mean of 150 burners may be applied without appreciable error to the Archereau and Carré carbons, and that of 205 to the Gaudoin carbons.

Brought to a uniform section of 0.0001 square metre, the consumption of the carbon was respective-
8518 ly:

For retort carbons,	51 millimetres.
Archereau "	66 "
Gaudoin "	73 "
Carré "	77 "

In proportion to the light produced, this consumption was:

For the Gaudoin carbons,	35 mills.	per 100 burners.	
8519 " Archereau "	44 "	"	
" Carré "	51 "	"	
" retort "	49 "	"	

These experiments were made with a Gramme machine constructed by M. Brèguet and a Carré lamp by the same maker. The carbons were taken at hazard from a lot of several metres for each series.

At the request of one of the inventors we made some fresh experiments, with the co-operation of
8520 Messrs. Gramme and Lemonnier, with a more powerful Gramme machine and a Serrin lamp.

The following table (B) contains the mean of three series of experiments made with the greatest precision. The electric lamp was placed, quite vertically, at the same level as the oil-lamp and photometer. Every precaution was taken that there should not be any sensible error in the measurements of the luminous intensity.

Brought to a uniform section of 0.0001 square 8521
metre, the consumption of the carbons was respectively in these new experiments:

For the Carré carbons,	44 millimetres.
" Retort	49 "
" Archereau	53 "
" Gaudoin (wood carbon)	61 "
" Gaudoin, No. 1,	78 "

In proportion to the light produced, this consump- 8522
tion was:

For the Gaudoin (wood carbon)	32 mills.	per 100 burners.
" Archereau	39 "	"
" Carré	40 "	"
" Gaudoin, No. 1	40 "	"
" Retort	50 "	"

The light given by the Gaudoin carbons was a little less regular than that observed 6th November, 1876. That given by the Carré carbons varied in less than a 8523
minute from 100 to 250 burners; the arc rotated positively round the points, the same as if alternating currents were being used. The Archereau carbons appeared to us less effective than at the first trial; they were consumed slowly, but they produced a light so variable that it was difficult to take photometric measurements. Only the retort carbons maintained their duration, luminous intensity, and, unfortunately, their irregularity.

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TABLE B.

RESULTS OF EXPERIMENTS UPON SEVERAL CARBONS, 4th April, 1877.

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Name of Carbon.	Form and dimensions.	Section in square millimetres.	Total consumption per hour in millimetres.	Mean light in Carcel burners.	Length of the arc in millimetres.	Revolutions per minute of the machine.	Regularity.	Observations.
Retort carbon, good quality.	Square. 9 m.m. in the side.	81	60	120	2.5	820	Passable.	Splinters numerous. Separation of a a small piece. Scintillation. Carbons were shaped very irregularly.
Archereau's carbons, new specimen.	Round. 10 m.m. diameter.	78	68	173	3	820	Null.	Disaggregation. Sparks. Light very variable in intensity at periods. Shaping into small facets.
Carré's carbons, new specimen.	Round. 9 m.m. diameter.	64	69	175	3	820	Middling.	Small sparks. Light running round. Very variable in intensity. Good shaping of the carbons.
Gaudoin's, Type, No. 1.	Round. 11.2 m.m. diameter.	98	80	203	3	820	Good.	Neither sparks nor splinters. Light a little red, but pretty constant.
Gaudoin's [Agglomeration of wood carbon.]	Round.	...	78	240	3	820	Sufficiently good.	Light very white. Less steady than with Gaudoin's carbons, No. 1. No sparks. Small variations.

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We shall describe, in terminating this chapter, the improvements that M. Gaudoin has made in his process, and patented 7th April, 1877.

Instead of carbonizing wood, reducing it to powder, and then submitting it to mixture, the inventor takes dried wood, properly chosen, to which he gives the definite form of the carbon, then he converts it into hard carbon, and finally soaks it, as in the manufacture we have described.

The distillation of the wood is effected slowly, in 8530
such manner as to drive out the volatile substances, and the final desiccation is made in a reducing atmosphere, at a very high temperature. A previous washing in acids or alkalies, removes from the wood any impurities that it possessed.

M. Gaudoin points out also the means of filling up the pores of the wood, by heating to redness, and submitting it to the action of chloride of carbon and different carbides of hydrogen. He hopes thus to produce electric carbons of small consumption and giv- 8531
ing an absolutely steady light.

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Defendant's Exhibit Sidot Article.

Comptes Rendus, Tome LXX., Page 605.

Mémoires Présentés.

CHIMIE.—Action du sulfure de carbone et des gaz car-
8534 burés sur le charbon de bois.

Note de M. SIDOT. (Extrait.)

(Commissaires: MM. Becquerel, Dumas, Boussingault, Balard, H. Sainte-Claire Deville.)

"Dans un précédent travail, j'ai montré que le sulfure de carboné était décomposé par le charbon, que celui-ci augmentait de poids, et que du soufre était mis en liberté. En poursuivant ces recherches j'ai examiné comment le sulfure de carbone agit sur cer-
8535 tains corps organiques de nature végétale ou animale.

"Dans un tube de porcelaine, j'introduis de petits faisceaux de bois, sur lesquels je commence par faire passer, à froid, de la vapeur de sulfure carbone, afin d'expulser tout l'air du tube. Ce premier résultat obtenu, je chauffe le tube lentement et graduellement, jusqu'à la chaleur rouge, pendant une heure environ.

"Après le refroidissement, on trouve dans le tube des baguettes d'un charbon, différant, par ses propriétés phisiques, du charbon ordinaire. Les essences
8536 de bois les plus diverses, le buis, le frêne, le charme, le lilas, le sureau et le liége peuvent donner naissance à ce nouveau charbon. Ce qui le distingue avant tout, c'est sa sonorité, entièrement semblable à celle des corps réputés les plus sonore, tels que l'acier, l'argent, l'aluminium, le cristal, etc. J'ai l'honneur de mettre sous les yeux de l'Académie quelques échantillons de ces charbons sonores. Lorsqu'on en suspend un au moyen d'un fil et qu'on le frappe dessus, il rend un son métallique.

"Voulant obtenir avec ce charbon un instrument 8537
sonore, j'ai tourné une sonnette en bois de frêne, et je l'ai soumise à l'action du sulfure de carbone d'après le procédé que je viens de décrire. Ce morceau de frêne est devenu une sonnette, que je présente également a l'Académie: elle donne un son comparable a celui d'un sonnette en métal de même diamètre. Je conclus de ces faits qu'il serait facile de reproduire la gamme avec un claque-bois en charbon, et de construire un harmonica avec des clochettes pareillement 8538
en charbon. Les bois très-durs semblent donner les sons les plus purs et les plus harmonieux.

"Les mêmes charbons, que leur élasticité distingue si nettement des charbons ordinaires, s'éloignent encore de ces derniers par leur grande conductibilité pour la chaleur et l'electricité. J'estime qu'ils pourraient peut-être remplacer les charbons de la pile de Bunsen.

"Les crayons qu'on en compose donnent une lumière électrique beaucoup plus intense que la 8539
lumière que l'on obtient avec le charbon des cornues à gaz. Ce charbon conducteur s'échauffe à la facon d'un métal, et devient progressivement incandescent dans toute la masse, sans s'allumer sur une de ses points, comme le charbon ordinaire; il se refroidit aussitôt qu'on l'a retiré du feu. On peut le caractériser, au point de vue de la conductibilité, en disant que c'est du *charbon de bois transformé en coke.*

"J'ai obtenu des résultats analogues avec le lin,
le chanvre, le coton, le papier, la soie. 8540

"Le charbon que j'ai obtenu avec le bois possède l'éclat métallique, mais cet éclat n'est que superficiel.

"Il a une densité plus grande que celle du charbon de bois.

"Il n'absorbe plus sensiblement les gaz. Je ferai remarquer, à ce propos, qu'en chauffant à haute température le bois dans un creuset rempli de braise finement pulvérisée, on obtient aussi un charbon dénué de propriétés absorbantes, et, de plus, bon conducteur.

8541 "Le sulfure de carbone n'est pas le seul agent de cette remarquable transformation du bois en charbon sonore et conducteur.

"L'esprit de bois, les carbures d'hydrogène, etc., changent semblablement le bois en charbon élastique et conducteur. Il y a plus : je me suis assuré qu'en faisant passer de la vapeur d'alcool méthylique sur du bois chauffé au rouge, dans un tube de porcelaine, cette vapeur se trouve décomposée, et qu'en même
8542 temps les parois intérieures du tube se tapissent d'un charbon très-singulier. Ce charbon, en effet, se présente sous la forme de filaments longs de 1 centimètre, constituant une espèce de coke soyeux et mousseux, d'un blanc d'argent. Ces filaments paraissent être formés par de petites boules juxtaposées.

Translation. 8545

Comptes Rendus, Vol. 70, page 605.

Meeting of Monday, March 21, 1870.

Memoirs Presented.

CHEMISTRY.—The Action of Carbon-bisulphide and carburetted gases, on wood charcoal. 8546

Note by M. SIDOT. (Extract.)

(Commission : Becquerel, Dumas, Boussingault, Balard, H. Sainte-Claire Deville.)

"In a preceding work, I have shown that carbon-bisulphide was decomposed by carbon ; that the latter increased in weight, and that sulphur was set free. In 8547
pursuing these researches, I have examined the manner in which carbon-bisulphide acts on certain organic substances of vegetable or animal origin.

"I placed in a porcelain tube, little bundles of wood, over which, while cold, I passed the vapor of carbon-bisulphide, in order to drive all the air from the tube. This result obtained, I then slowly and gradually heated the tube up to a red heat for about one hour.

"After cooling, we find in the tube rods of a char- 8548
coal, differing in its physical properties from ordinary charcoal. The most varied species of wood, the box, ash, witch-elm, lilac, elder, and the cork tree, all yield this new charcoal. That which especially distinguishes it is its sonorousness, similar to that of the most sonorous bodies, such as steel, silver, aluminum, glass, &c. I have the honor to place before the Academy several specimens of these sonorous charcoals. When

8549 suspended by means of a thread, and struck below, they gave a metallic sound.

"Wishing to obtain with this charcoal a sonorous instrument, I turned a wooden bell from a piece of ash, and then subjected it to the action of carbon-bisulphide, according to the process I have just described. The piece of ash became a bell, which I also present to the Academy; it gives a sound comparable to that of a bell of metal of the same diameter. I conclude from these facts that it would be easy to produce the gamut
8550 with a claque-bois (xylophone) of charcoal, and to construct a harmonicon with little charcoal bells. The very hard woods appear to give the purest and most harmonious sounds.

"These charcoals, that are distinguished so clearly by their elasticity from ordinary charcoals, are separated still further from the latter by their great conductibility for heat and electricity. I suppose that they might replace the carbons of the Bunsen Cell.

"Pencils made from these charcoals give an electric
8551 light much more intense than that obtained with the carbon of the gas retort. This charcoal conductor heats after the manner of a metal, and becomes gradually incandescent throughout its entire mass, without igniting at one of the points, as ordinary charcoal, and begins to cool as soon as removed from the fire. We can characterize it, as regards its conductibility, by saying that it is wood charcoal transformed into coke.

"I have obtained similar results with linen, hemp,
8552 cotton, paper and silk.

"The charcoal that I have obtained from wood has a metallic lustre, but this is confined to the surface.

"It has a density greater than that of wood charcoal.

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"It does not absorb gas so sensibly. I must say in this connection that in heating wood to a high temperature in a crucible filled with finely pulverized coals (embers) we also obtain a charcoal with but little absorbing powers, and moreover a good conductor.

"Carbon-bisulphide is not the only agent for affecing this wonderful transformation of wood into sonorous and conducting charcoal.

"Wood-spirits, carburetted hydrogen, etc., also change wood into elastic and conducting charcoal. Moreover, I have assured myself that by passing the 8554
vapor of methyllic alcohol over wood heated to redness, in a porcelain tube, the vapor is decomposed, and at the same time the interior walls of the tube are lined with a very peculiar charcoal. This charcoal, in fact, is in the form of filaments of about one centimetre in length, forming a kind of silky, mossy coke of a silvery white. These filaments appear to be formed of little spheres placed in juxtaposition.

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Defendant's Exhibit Gaudnin Certificate of Addition.

CERTIFICATE OF ADDITION, taken out April 7th, 1877, by Mr. Gauduin, Octave, at Paris, rue de la Roquette 130, and which relates to letters patent, for fifteen years, taken out 12th July, 1876, for a carbon intended for the manufacture of utensils of chemistry and
8558 physics, etc., * * * the said certificate of addition granted by order of the Minister of Agriculture and Commerce, on June 22d, 1877.

CERTIFICATE OF ADDITION TO LETTERS PATENT, NO. 113,706.

I have succeeded in giving to my carbon the definite form which it is to preserve, and in simplifying considerably the moulding and the forming of the objects which I manufacture by the following process:

8559 I form the crucibles, vessels, pencils for electric lighting or for electro-chemistry, etc., out of properly-selected dry wood, by all the methods proper to working in wood. I convert this wooden object into a hard and compact carbon, preserving its original form, by drying it suitably, impregnating it with tar, pitch, bitumen, resin, essences and oils of coal, any carbon of hydrogen, sugar, caramel or other matter possessing analogous properties.

8560 I distill it slowly so as to expel the volatile bodies; I impregnate it anew and re-distill it as many times as necessary, and finally I heat it to a high (degree of) temperature in a reductive atmosphere.

For objects which require a very pure carbon, like the pencils for electric lighting, it is good to wash the carbon object when it is still porous, with acids and

alkalies, so as to dissolve the impurities which it may contain, and to rinse it afterward in plenty of water. 8561

I can also heat it to a red heat and submit it during a certain time to the action of chloride of carbon, hydro-chloric and hydrofluoric gaseous acids. I finish by vapors of carburet of hydrogen capable of stopping the pores by depositing carbon in them.

I also manufacture articles of carbon from cotton, hemp, flax, cellulose in any state, kneaded and impregnated with pitch, tar, etc., and formed so as to 8562
give it the desired shape. I finish them as if the object were of impregnated wood.

To recapitulate:

By the present Certificate of Addition, I claim the manufacture of crucibles, pencils for electric lighting and electro-chemistry, vases and utensils of any kind, by converting the wood and the cellulose into carbon by the means described above, or by analogous means.

PARIS, 7th April, 1877.

Signed: OCTAVE GAUDUIN. 8563

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Defendant's Exhibit Edison's American Association Paper.

PROCEEDINGS

OF

THE AMERICAN ASSOCIATION

8566 for the

ADVANCEMENT OF SCIENCE,

Twenty-eighth Meeting,

held at

Saratoga Springs, N. Y.,

August, 1879.

SALEM:

8567 PUBLISHED BY THE PERMANENT SECRETARY.

1880.

ON THE PHENOMENA OF HEATING METALS IN VACUO BY MEANS OF AN ELECTRIC CURRENT. BY THOS. A. EDISON, OF MENLO PARK, N. J. (PAGE 173)

In course of my experiments on electric lighting I
have developed some striking phenomena arising from
the heating of metals by flames and by the electric
8568 current, especially wires of platinum and platinum
alloyed with iridium. The experiments are still in
progress.

The first fact observed was, that platinum lost weight when heated in a flame of hydrogen, that the metal colored the flame green, and that these two results continued until the whole of the platinum in contact with the flame had disappeared.

A platinum wire four-thousandths of an inch in diameter and weighing 306 milligrammes was bunched

together and suspended in a hydrogen flame; it lost 8569
weight at a fraction less than one milligramme per
hour as long as it was suspended in the flame.

When the platinum wire is stretched between two
clamping posts and arranged to pass through a hydro-
gen flame, it is colored a light green, but when the
temperature of the wire is raised above that of the
flame by passing a current through it, the flame is col-
ored a deep green. To ascertain the diminution in the
weight of a platinum wire when heated by the electric 8570
current, I placed between two clamping posts a wire
five-thousandths of an inch in diameter and weighing
266 milligrammes. This wire, after it was brought to
incandescence for twenty minutes by the current, gave
a loss of three milligrammes. Afterwards it was kept
incandescent for one hour and ten minutes, at which
time it weighed 258 milligrammes, a total loss of 8
milligrammes. Another wire, weighing 343 milli-
grammes was kept moderately incandescent for nine
consecutive hours, after which it weighed 301 milli- 8571
grammes, showing a total loss of 42 milligrammes. A
platinum wire twenty-one thousandths of an inch in
diameter was wound in the shape of a spiral, $\frac{1}{4}$ of an
inch in diameter and $\frac{1}{2}$ of an inch in length. The two
ends of the spiral were secured to clamping posts, and
the whole apparatus was covered with a glass shade
$2\frac{1}{2}$ inches in diameter and 3 inches high. Upon bring-
ing the spiral to incandescence for twenty minutes,
that part of the globe in line with the sides of the
spiral became slightly darkened; in five hours the de- 8572
posit became so thick that the incandescent spiral
could scarcely be seen through the deposit. This film,
which was most perfect, consisted of platinum and I
have no doubt but large plates of glass might be coated
economically by placing them on each side of a large
sheet of platinum kept incandescent by the electric cur-
rent.

8573 This loss in weight, together with the deposit upon the glass, presented a very serious obstacle to the use of metallic wires for giving light by incandescence, but this was easily surmounted after the cause was ascertained. I coated the wire forming the spiral with the oxide of magnesium, by dusting upon it powdered acetate of magnesium. While incandescent the salt was decomposed by the heat and there remained a strongly adherent coating of the oxide. This spiral,
8574 so coated, was covered with a glass shade and brought to incandescence for several minutes, but, instead of a deposit of platinum upon the glass, there was a deposit of oxide of magnesia. From this and other experiments I have become convinced that this effect was due to the washing action of the air upon the spiral. That the loss of weight in and the coloration of the hydrogen flame was also due to the wearing away of the surface of the platina by the attrition produced by the impact of the stream of gases upon the highly incandescent
8575 surface, and not to volatilization as commonly understood. After the experiment last described, I placed a spiral of platinum in the receiver of a common air pump and arranged it in such a manner that the current could pass through while the receiver was exhausted. At a pressure of 2 millimetres, the spiral was kept at incandescence for two hours before the deposit was sufficient to become visible. In another experiment, at a higher exhaustion, it required five hours before a deposit became visible.

8576 In a sealed glass bulb, exhausted by a Sprengel pump to a point where a ¼ inch spark from an induction coil would not pass between points one millimetre apart, was placed a spiral, the connecting wires passing through the glass. This spiral has been kept at the most dazzling incandescence for hours without the slightest deposit becoming visible.

I will now describe other and far more important phenomena connected with my experiments.

If a short length of platinum wire, one-thousandth 8577
of an inch in diameter, be held in the flame of a Bunsen burner, at some part it will fuse and a piece of the wire will be bent at an angle by the action of the globule of platinum. In some cases there are several globules formed simultaneously, and the wire assumes a zig-zag shape.

With a wire four one-thousandths of an inch in diameter this effect does not take place, as the temperature cannot be raised to equal that of the smaller 8578
wire, owing to the increased radiating surface and mass. After heating, if the wire be examined under a microscope, that part of the surface which has been incandescent will be found covered with innumerable cracks. If the wire be placed between clamping posts and heated to incandescence for twenty minutes, by the passage of the electric current, the cracks will be so enlarged as to be seen with the naked eye. The wire under the microscope presents a shrunken appearance and is full of deep cracks. If the current is continued 8579
for several hours these effects will so increase that the wire will fall to pieces.

This disintegration in platina, long subjected to the action of a flame, has been noticed by Prof. John W. Draper. The failure of the process of lighting invented by the French chemist, Tessiè du Motay, who raised sheets of platina to incandescence by introducing it into a hydrogen flame, was due to the rapid disintegration of the metal.

I have ascertained the cause of this phenomena and have succeeded in eliminating that which produces it, 8580
and in doing so have produced a metal in a state hitherto unknown and which is absolutely stable at a temperature where nearly all substances melt or are consumed; a metal which, although originally soft and pliable, becomes as homogeneous as glass and as rigid as steel. When wound in the form of a spiral, it is as

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springy and elastic when at the most dazzling incandescence as when cold, and which cannot be annealed by any process now commonly known.

The cause of this springing and cracking of the wire is due entirely to the expansion of the air in the mechanical and physical pores of platinum, and the contraction upon the escape of the air

Platinum, as sold in commerce, may be compared to sandstone, in which the whole is made up of a great number of particles with many air spaces. The sand-
8582 stone upon melting becomes homogeneous and no air spaces exist. With platinum or any metal, the air spaces may be eliminated and the metal made homogeneous by a very simple process. This process I will now describe.

I had made a large number of platinum-iridium spirals, all of the same size and from the same quality of wire. Each spiral presented to the air a radiating surface of three-sixteenths of an inch; five of these were brought by the electric current up to the melting
8583 point. The light was measured by a photometer, and the average light was equal to four standard candles for each spiral just at the melting point. One of the same kind of spirals was placed in the receiver of an air pump, and the air exhausted to two millimetres, a weak current was then passed through the wire to slightly warm it, for the purpose of assisting the passage of air from the pores of the metal into the vacuum. The temperature of the wire was gradually augmented, at intervals of ten minutes, until it became red. The
8584 object of slowly increasing the temperature was to allow the air to pass out gradually, and not explosively. Afterwards, the current was increased at intervals of fifteen minutes. Before each increase in the current the wire was allowed to cool, and the contraction and expansion at these high temperatures caused the wire to melt together at the points previously containing air. In one hour and forty minutes this spiral had

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reached such a temperature without melting that it was giving a light of twenty-five standard candles, whereas it would undoubtedly have melted before it gave a light of five candles had it not been put through the above process. Several more spirals were afterwards tried with the same result. One spiral, which had been brought to these high temperatures more slowly, gave a light equal to thirty standard candles. In the open air this spiral gave nearly the same light, although it required more
current to keep it at the same temperature. 8586

Upon examination of these spirals which had passed through the vacuum process, by the aid of a microscope, no cracks were visible, the wire had become as white as silver and had a polish which could not be given it by any other means. The wire had a less diameter than before treatment, and it was exceeding difficult to melt in the oxy-hydrogen flame as compared with untreated platinum. It was as hard as the steel wire used in pianos and it could not be annealed at any
temperature; it was also scarcely attacked by boiling 8587
aqua regia.

My experiment with many metals treated by this process has proved to my satisfaction, and I have no hesitation in stating that what is known as annealing of metals, to make them soft and pliable, is nothing more than the cracking of the metal. In every case where a hard drawn wire had been annealed, a powerful microscope revealed myriads of cracks in the metal.

Since the experiments of which I have just spoken, 8588
I have by the aid of Sprengel mercury pumps produced higher exhaustions and have, by consuming five hours in excluding air from the wire and intermitting the current, a great number of times succeeded in obtaining a light of eight standard candles from a spiral of wire with a total radiating surface of one-thirty-second

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of an inch, or a surface about equal to a grain of buckwheat. With spirals of this small size which have not passed through the process the average amount of light given out before melting is less than one standard candle. Thus I am enabled by the increased capacity of platinum to withstand high temperatures to employ small radiating surfaces and thus reduce the energy required per candle light. I can now obtain eight separate jets, each giving out an abundantly steady light,
8590 and each equal to sixteen standard candles or a total of one hundred and twenty-eight standard candles by the expenditure of 30,000 foot pounds of energy, or less than one horse-power.

As a matter of curiosity I have made spirals of other metals, and excluded the air from them in the manner stated. Common iron wire may be made to give a light greater than platinum not treated. The iron becomes as hard as steel and just as elastic. Nickel is far more refractory than iron. Steel wire
8591 used in pianos becomes decarbonized, but remains hard and assumes the color of silver. Aluminum melts only at white heat.

In conclusion, it may be interesting to state that the melting points of many oxides are dependent upon the manner of applying heat. For instance, pure oxide of zirconium does not fuse in the flame of the oxy-hydrogen blow-pipe, while it melts like wax and conducts electricity when on an incandescent platinum spiral which is at a far lower temperature. On the
8592 other hand oxide of aluminum easily melts in the oxy-hydrogen flame, while it only vitrifies on the platinum spiral.

A. A. A. S., Vol. XXVIII. 12.

8593

Defendant's Exhibit Telegraphic Journal Article of October 1, 1879.

The Telegraphic Journal and Electrical Review.

London: Haughton & Co., 1879.

Vol. VII, No. 160, October 1, 1879. 8594

Pages 320 and 321.

HEATING METALS IN VACUO BY THE ELECTRIC CURRENT.

A very interesting paper, by Mr. T. A. Edison, was read before the American Association at Saratoga the other day:

"In the course of my experiments on electric lighting," says the author. "I have developed some striking phenomena arising from the heating of metals 8595
by flames and by the electric current, especially wires of platinum and platinum alloyed with iridium. These experiments are still in progress.

"The first fact observed was that platinum lost weight when heated in a flame of hydrogen, that the metal colored the flame green, and that these two results continued until the whole of the platinum in contact with the flame had disappeared.

"A platinum wire, twenty-thousandths of an inch in diameter was wound in the form of a spiral one- 8596
eighth of an inch in diameter and half an inch in length. The two ends of the spiral were secured to clamping posts, and the whole apparatus was covered with a glass shade. Upon bringing the spiral to incandescence for twenty minutes that part of the globe in line with the sides of the spiral became slightly darkened; in five hours the deposit became so thick that the incandescent spiral could not be seen through

8597 the deposit. This film, which was most perfect, con-
sisted of platinum, and I have no doubt but that large
plates of glass might be coated economically by plac-
ing them on each side of a large sheet of platinum,
kept incandescent by the electric current. This loss
in weight, together with the deposit upon the glass,
presented a very serious obstacle to the use of met-
allic wires for giving light by incandescence, but this
was easily surmounted after the cause was ascertained.
8598 I coated the wire forming the spiral with the oxide
of magnesium by dusting upon it finely powdered
acetate of magnesium. While incandescent the salt
was decomposed by the heat, and there remained a
strongly adherent coating of the oxide. This spiral
so coated was covered with a glass shade and brought
to incandescence for several minutes; but instead of
a deposit of platinum upon the glass there was a de-
posit of the oxide of magnesia. From this and other
experiments I became convinced that this effect was
8599 due to the washing action of the air upon the spiral;
that the loss of weight in and the colouration of the
hydrogen flame was also due to the wearing away of
the surface of the platina by the attrition produced
by the impact of the stream of gases upon the highly-
incandescent surface, and not to volatilisation, as
commonly understood.

"I will now describe the other and far more im-
portant phenomena observed in my experiments.

"If a short length of platinum wire, one-thousandth
8600 of an inch in diameter, be held in the flame of a Bun-
sen burner, at some part it will fuse and a piece of
the wire will be bent at an angle by the action of
the globule of melted platinum; in some cases there
are several globules formed simultaneously, and the
wire assumes a zig zag shape.

With a wire four-thousandths of an inch in diame-
ter this effect does not take place, as the temperature

cannot be raised to equal that of the smaller wire 8601
owing to the increased radiating surface and mass.
After heating, if the wire be examined under a micro-
scope, that part of the surface which has been incan-
descent will be found covered with innumerable
cracks. If the wire be placed between clamping
"posts, and heated to incandescence for twenty min-
utes by the passage of an electric current, the cracks
will be so enlarged as to be seen with the naked eye
the wire under the microscope presents a shrunken 8602
appearance, and is full of deep cracks. If the current
is continued for several hours these effects will so
increase that the wire will fall to pieces.

This disintegration has been noticed in platina
long subjected to the action of a flame, by Prof. John
W. Draper. The failure of the process of lighting in-
vented by the French chemist, Tessié-du-Motay, who
raised sheets of platinum to incandescence by intro-
troducing them into a hydrogen flame, was due to the
rapid disintegration of the metal. I have ascertained 8603
the cause of this phenomenon, and have succeeded
in eliminating that which produces it, and in doing
so have produced a metal in a state hitherto unknown,
and which is absolutely stable at a temperature
where nearly all substances melt or are consumed, a
metal which, although originally soft and pliable,
becomes as homogeneous as glass and as rigid as
steel. When wound in the form of a spiral it is as
springy and elastic when at the most dazzling incan-
descence as when cold, and cannot be annealed by 8604
any process now commonly known.

For the cause of this shrinking and cracking of the
wire is due entirely to the expansion of the air in the
mechanical and physical pores of the platinum, and
the contraction upon the escape of the air. Plati-
num as sold in commerce may be compared to sand-
stone in which the whole is made of a great number
of particles with many air spaces. The sandstone up-
on melting becomes homogeneous and no air spaces

8605 exist. With platinum or any metal the air spaces
may be eliminated and the metal made homogeneous
by a very simple process. This process I will now de-
scribe. I had made a large number of platinum spirals,
all of the same size and from the same quality of wire;
each spiral presented to the air a radiating surface
of three and one-sixteenth of an inch; five of these
were brought by the electric current up to the melt-
ing point, the light was measured by a photometer,
8606 and the average light was equal to four standard can-
dles for each spiral just at the melting point. One
of the same kind of spirals was placed in the receiver
of an air pump and the air exhausted to two milli-
meters; a weak current was then passed through
the wire to warm it slightly for the purpose of as-
sisting the passage of the air from the pores of the
metal into the vacuum. The temperature of the
wire was gradually augmented at intervals of ten
minutes until it became red. The object of slowly
8607 increasing the temperature was to allow the air to
pass out gradually and not explosively. Afterward
the current was increased at intervals of fifteen min-
utes. Before each increase in the current the wire
was allowed to cool, and the contraction and expansion
at these high temperatures caused the wire to weld
together at the points previously containing air. In
one hour and forty minutes this spiral had reached
such a temperature without melting that it was giv-
ing a light of twenty-five standard candles, whereas
8608 it would undoubtedly have melted before it gave a
light of five candles had it not been put through the
above process. Several more spirals were afterward
tried, with the same result. One spiral which had
been brought to these high temperatures more
slowly gave a light equal to thirty standard candles.
In the open air this spiral gave nearly the same
light, although it required more current to keep it
at the same temperature.

Upon examination of these spirals, which had passed 8609
through the vacuum process, by the aid of a micro-
scope, no cracks were visible; the wire had become
as white as silver, and had a polish which could not
be given it by any other means. The wire had a
smaller diameter than before treatment, and it was
exceedingly difficult to melt in the oxy-hydrogen
flame, as compared with untreated platinum; it was
found that it was as hard as the steel wire used in
pianos, and that it could not be annealed at any tem- 8610
perature.

My experiments with many metals treated by
this process have proved to my satisfaction, and I
have no hesitation in stating, that what is known as
annealing of metals to make them soft and pliable is
nothing more than the cracking of the metal. In
every case where a hard drawn wire had been an-
nealed a powerful microscope revealed myriads of
cracks in the metal.

Since the experiments of which I have just spoken, 8611
I have, by the aid of Sprengel mercury pumps, pro-
duced higher exhaustions, and have, by consuming,
five hours in excluding the air from the wire and inter-
mitting the current a great number of times, succeeded
in obtaining a light of eight standard candles from a
spiral of wire with a total radiating surface of 1-32 of
an inch, or a surface about equal to a grain of buck-
wheat.

With spirals of this small size which have not
passed through the process the average amount of
light given out before melting is less than one stand- 8612
ard candle. Thus I am enabled by the increased
capacity of platinum to withstand high tempera-
tures, to employ small radiating surfaces, and thus
reduce the energy required for candle-light. I can
now obtain eight separate jets, each giving out an
absolutely steady light, and each equal to sixteen
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8613 twenty-eight candles, by the expenditure of thirty thousand foot-pounds of enery, or less than one horse-power.

As a matter of curiosity I have made spirals of other metals, and excluded the air from them in the manner stated. Common iron wire may be made to give a light greater than platinum not heated. The iron becomes as hard as steel and just as elastic. Nickel is far more refractory than iron. Steel wire used in pianos becomes decarbonized, but remains
8614 hard and assumes the colour of silver. Aluminum melts only at a white heat."

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Defendant's Exhibit Extracts From Edison Bulletins. 8617

TWENTIETH BULLETIN.

THE EDISON ELECTRIC LIGHT COMPANY.

65 Fifth Avenue, New York.

OCTOBER 31st, 1883. 8618

(These bulletins, originally issued as a convenient way of answering the inquiries of distant agents, are now, in response to numerous requests, sent also to all stockholders, to give them information of the progress of the Company, and of other matters of greater or less interest connected with electric lighting. Agents are particularly requested to communicate to the President whatever practical points of general interest may be developed by their experience in installing or operating our lights.) 8619

Pages 41 to 50.

ANNUAL STOCKHOLDERS' MEETING. EDISON ELECTRIC LIGHT COMPANY. OFFICERS ELECTED. ANNUAL REPORT.—The Fifth Annual Meeting of the Stockholders of the Edison Electric Light Company was held at the office of the company, No. 65 Fifth Avenue, N. Y. City, October 23d, 1883. The following officers and directors were elected for the following year: President, S. B. Eaton; Vice-President, Edward H. Johnson; Treasurer 8620
and Secretary *pro tem.*, F. S. Hastings; Directors, Norvin Green, S. B. Eaton, G. P. Lowrey, Thomas A. Edison, J. Hood Wright, Henry Villard, James H. Banker, Calvin Goddard, Edward D. Adams, Anthony J. Thomas, J. E. de Navarro, Edward H. Johnson and W. H. Meadowcroft. The following Annual Report of the Board of Directors, provided for in the by-laws, was submitted to the meeting:

[NOT FILMED: PAGES 2156-2177 (TWENTIETH BULLETIN, PAGES 41-50; TWENTY-FIRST BULLETIN, PAGES 54-62)]

8709
Defendant's Exhibit Lane-Fox Letter to London Times.

THE LONDON TIMES, DECEMBER 26, 1878.

ELECTRIC LIGHTING.

To the Editor of the Times:

8710 Sir.—The question whether ultimately gas is to be entirely superseded by electricity is now occupying so much public attention, and the opinions on the subject are so various and so vague, that a few remarks enumerating one or two actual facts relating to the subject may be of interest to your readers.

Before, however, entering into the matter in detail
and before attempting to compare the relative value of
these or any two systems having the same objects
8711 and purpose, it would be well, in the first place,
to have clearly and definitely stated what are the intended functions of the said systems and what are the results to be arrived at by their means. Speaking broadly, therefore, it may be said that a plan or scheme is wanted for the economical application and distribution of energy on a large scale, whether for lighting, heating, or for the development of motive power.

Thus, in the case of gas, as at present applied, a
8712 manufactured fuel is transmitted and distributed,
energy being derived from the combustion of this fuel at its point of application, while by the proposed electric system, with which gas is now threatened, the energy itself is to be transmitted and distributed, which energy has been developed at a distance from its point of application either by the combustion of

8713
coal or peat, suitably applied to certain arrangements or mechanism, or else from some natural source, such as a fall of water or the force of wind. I propose to deal only with energy from combustion. The primary matter for consideration is naturally that of cost. Coal gas at the manufacturing price, say 2s. a thousand cubic feet, amounts to about £6 a ton. The best available fuel for raising steam would in London average about 15s. a ton. The value of ordinary coal-
gas as a fuel may be taken as equal to that of coal, 8714
weight for weight, so that the cost of the total quantity of energy capable of being derived from the combustion of a certain weight of coal is about eight times less than a similar amount derived from the combustion of gas.

With a good steam engine and boiler on a large scale about 12 per cent. of the total energy of combustion of a fuel can be converted into motive power, and in the conversion of this motive power into elec-
tric force by the most advantageous method there is a
loss of about 25 per cent. Thus, about 9 per cent. of 8715
the total energy of combustion of coal can be converted into electricity. I may here state, however, that although the conversion of 12 per cent. of the total energy represents fairly the yield of good engines of the present day, it is, nevertheless, extremely probable that before long this figure will be more than doubled. In the application of gas to heating purposes (without vitiating the atmosphere) probably 20
to 40 per cent. of its total energy of combustion can
be utilized; with the best gas engines a correspond- 8716
ing amount can be converted into motive power, while for lighting this amount is reduced to an extremely small fraction.

When an electric current passes through any conducting material, as is very well known, an amount of heat is developed in that material, exactly equal to the amount of energy expended in the transmission of

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the current through it, and consequently proportional to the resistance offered by the material to the passage of the electricity. When the heat produced in the material is sufficiently intense, it will become luminous, and the degree of luminosity it attains will, of course, depend on the degree of temperature to which it is raised, and although the percentage of energy thus transformed into light is probably small, it is, nevertheless, in proportion, enormously greater than is the case with gas.

8718 Motive power can be produced from electricity by means of magneto or dynamo electric machines. The conversion is, of course, attended with a certain amount of loss; about 75 per cent. of the electric force can, however, be reclaimed. It will, therefore, be seen that so far as expense alone is concerned, the overthrow of gas is by no mean impossible. The question, therefore, resolves itself into whether electricity can be transmitted and distributed in such manner as to render its
8719 adoption practicable. I may say at once that I have myself no longer the slightest doubt that electricity can be so treated, and that its general adoption in the place of gas is only a matter of time. It is sure to be asked, "If this is really the case, why has it not been done long ago, or at any rate, why not directly?" Without attempting to answer this question fully, I would simply say, that the means of producing electricity until lately were very inadequate, and the methods of applying it for lighting were open to the gravest objections
8720 and presented numerous defects, the most flagrant of which is the vibratory character imparted to the electric influence through the incessant variation of resistance which an electric arc presents, as well as the variation of electromotive force resulting from the intermittent action of the generating apparatus. This matter was discussed at some length in a letter you did me the honor of publishing a short time back.

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The first difficulty will probably disappear with the electric arc itself; and as to the second, there is no doubt that when electricity is generated on a large scale, the numerous electromotors which would be required, pouring in their combined influence, would, with the aid of condensors, produce a constant electromotive force, and so insure an even and continuous flow of electricity; and when once this is attained, Ohm's law is again applicable and the whole subject becomes remarkably simple. 8722

The way in which it is proposed to "lay on" electricity to any given district or town is somewhat similar to the arrangements for gas. There would have to be, in the first place, one or more electrical generating stations, where there would be the requisite steam power and a number of electric engines. From these stations would proceed in every direction copper conducting mains, one pole or terminal of each one of the electric engines would be in connection with these mains, the other by means of gas or water pipes 8723
would be connected with the "earth." In this manner when the electric engines are in action the conducting mains would become charged with electricity to a certain tension, or, as it may be said, electricity will be driven into them until a certain electrical pressure is reached. The action of the electric engines would be regulated automatically according to the draught on the mains. The tendency of this electrical pressure would be to develop currents in every direction to the earth. From various points of these 8724
mains smaller mains would be made to branch off, and from these again would proceed other branches, and so on: the conductors would, in fact, running along under the roadway, form a kind of network throughout the town, so that wherever light or heat is required, a lamp or other apparatus would simply have to be connected "in circut," between the mains at that point and the earth (gas or water pipes).

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The apparatus used for both lighting and heating would be constructed so that the current passes through a continuous conductor, suitably arranged and made of some suitable material—such, for instance, as platinum, iridium, iron, carbon, etc. For lighting, the conductor would have to be enclosed in a hermetically sealed glass globe to prevent its deterioration from gradual combustion by contact with the air. For heating, the arrangement and disposition of these con-
8726 ductors would, of course, depend on the purpose for which the heat was required. For boiling, stewing, etc., the best way of obtaining heat would be to arrange a conductor in the annular space between two vessels, one inside the other and surrounding it with oil or some similar liquid. In this manner the whole of the heat generated in the conductor by the passage of electricity would be taken up by the oil and transferred to the substance to be boiled or cooked contained by the inner vessel.
8727 Thus it would seem that the application of electricity to culinary purposes may be made extremely economical. Further, in as much as heat is thus produced without combustion, on the spot, and consequently without its resultant products, a so heated conductor might be used for the warming of rooms with great convenience and economy of power.

Now, since, as already stated, the amount of heat developed by a current during its passage through a conductor is proportional to the current's strength and varies as the resistance of the conductor, and since in
8728 a conductor made up of different parts the amount of heat developed in each part is directly proportional to the resistance of that part and inversely as its conductivity, therefore if the conductivity of the mains, taken as a whole, is ten times greater than the conductivity of the conductors used for lighting and heating taken as a whole, the loss of energy by transmission would be represented by 10 per cent. or the tenth part

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of the total force transmitted. By a proper adjustment of the conducting mains, the *maximum* variation of tension that could possibly arise at any point would thus be less than 10 per cent., while by the interposition of automatic regulating apparatus for the alteration of resistance at the junction of the branches, the *maximum* variation could be made indefinitely small.

In order to attain the proportionate conductivity referred to above, in a district of, say 6,000 houses, the supply conductors for lighting alone would prob- 8730
ably vary from one to three inches in diameter, while for the supply of light, heat, and power the chief or main conductors would possibly have to be as large as six inches in diameter. Although it may be objected that such large conductors of copper would be enormously expensive, it must be remembered that this metal is not liable to deterioration, and that sometimes gas mains themselves are as much as four feet in diameter.

These electrical conducting mains would of course 8731
have to be laid under the road in the same way as the gas mains; and in order to prevent the dissipation of the electricity they would have to be encased in a wooden trough and embedded in some suitable material—such, for example, as asphalt, pitch, paraffine, resin, &c. By this means loss through leakage would be insignificant. The fact that there is no practical means of storing up electricity in large quantities in the same way as gas, has been constantly put forward of late as being an insuperable objection to its intro- 8732
duction. In a certain sense it is true that electricity cannot be stored up in any large quantity; but when it is borne in mind that, after all, the use of electricity would be merely as a vehicle for the transmission of energy, the difficulty will soon vanish. There are many practical ways of storing up potential energy, and many practical ways of reconverting potential energy into a kinetic form.

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The above data appear to me to show conclusively that everything that can be done by gas can also be done by electricity, and at a much lower cost. The working expenses and outlay for plant would probably be about equal to that in the gas system. But, in addition to economy, electricity would have other numerous advantages over gas. The first of these, and perhaps the one of greatest importance, would be the possibility of obtaining light and heat by the mere
8734 turning of a handle and without the use of matches. This handle being in any convenient place and distance from the point where the light or heat is generated, and not necessarily as is the case with gas, within a few inches from the burner. Next the light emitted from the incandescent body would be absolutely steady, and of any degree or quality desired, from that of a dull red heat to an intense whiteness. But, even were these advantages to be lost sight of, the immense superiority of electricity on the score of safety must be
8735 recognized.

It would not here be possible for me to enter fully into details of the method of producing light by the incandescence of a continuous conductor of some refractory material. Suffice it to say that, although the devices for so obtaining light are still very crude and imperfect, there is not the slightest doubt that they will be very soon perfected. Much has been heard and said lately as to the merits and demerits of "the electric light," and as to the possibility of "subdividing
8736 it." These remarks and *data* have no reference to this great luminary, whatever it may be, and indeed, for all they show, the solution of the "problem of its subdivision" may be as difficult or impossible as the subdivision of the moon; yet, for all that, the facts remain.

I am, sir, your obedient servant,

ST. GEORGE LANE-FOX.

LONDON, Dec. 9.

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Defendant's Exhibit Silliman's Journal Article.

THE AMERICAN JOURNAL OF SCIENCE AND ARTS.

Editors: JAMES D. and E. S. DANA and B. SILLIMAN. Volume 117, third series, volume 17, published 8738
by the editors at New Haven in 1879, pages 65 and 66.

11. *On the Economy and Subdivision of the Electric Light.*—PROFESSOR FARMER of the torpedo station at Newport has written a letter to the Salem *Observer*, calling attention to the fact that the parlor of his house, No. 11 Pearl Street, was lighted every evening during the month of July, 1859, by the electric light, and that this electric light was subdivided, too. Since 8739
this was nineteen years ago, it was, he thinks, undoubtedly the first private dwelling-house ever lighted by electricity, a fact which may be a source of pride to the city of Salem some of these days. As we know of no one better qualified to give an opinion on these important questions, we give the latter portion of Professor Farmer's letter:

"A galvanic battery of some three dozen six-gallon "jars was placed in the cellar of the house, and it furnished the electric current, which was conveyed by "suitable conducting wires to the mantle-piece of the 8740
"parlor, where were located two electric lamps, on "each end of the mantle-piece—(I should not wonder "if the screw holes were there at this day). Either "lamp could be lighted at pleasure, or both at once, "by simply turning a little button to the right for a "light, to the left for a dark. No matches, no danger, "no care to the household, nor to anyone except to "the man who attended the battery.

8741 "The light was noticed as being soft, mild, agreeable to the eye, and more delightful to read or sew by than any light ever seen before. Its use was discontinued, at that time, for the simple reason that the acids and zinc consumed in the battery made the light cost about four times as much as an equivalent amount of gas-light. Now that we can have cheap electricity from the dynamo-electric machine, we may soon expect better things of it.

"In the year 1875 I subdivided an electric current
8742 into forty-two different branches, putting a light into each branch. All these lamps were supplied with electricity from one machine, which did not weigh more than eight hundred pounds, and which was driven by a small steam engine.

"Now a word as to the cost of electric light as compared with light from gas. Perhaps on the average, one pound of illuminating gas will, if burned in an hour in five different burners, give fifteen candle lights to each burner, or seventy-five candle lights in
8743 all. One pound of illuminating gas possesses a sufficient store of energy to enable it to give out by combustion, from eighteen thousand to twenty-one thousand units of heat, or the equivalent of from thirteen to sixteen million foot-pounds of work. This, if burned in an hour, would average from two hundred to two hundred and sixty thousand units of work per minute, or say from three thousand to thirty-five hundred foot-pounds per minute per candle light.

8744 "Now a very large electric light, say ten thousand candles, does not demand or consume more than fifteen or twenty foot-pounds of energy per minute per candle light, and even so small an electric light as twenty or thirty candles need not consume so much as two hundred foot-pounds per minute per candle

"light. So it might not seem very extravagant to expect that one pound of gas per hour could be burned in a suitable furnace under a proper boiler, and steam be taken from this boiler to a steam engine, and this engine drive a magnetic electric machine which should supply electricity to five electric lamps that would shed forth more light than could be given by five of the best gas lamps known, each lamp consuming at the rate of one-fifth of a pound of the best illuminating gas per hour; and this would not be half so absurd an expectation as it would have been three 8746
years ago, for some visionary to have predicted that the talking phonograph would succeed in embalming speech."

U. S. Naval Torpedo Station, Newport, R. I., Oct. 30, 1878.

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Defendant's Exhibit Engineering Article of May 14, 1880.

ENGINEERING.

Edited by William H. Maw and James Dredge.

London, Friday, May 14, 1880.

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Page 382.

EDISON'S HORSESHOE LAMP.

We have at last a glimmering of truth upon the real value of the carbon horseshoe lamp invented by Mr. Edison at the close of last year. A very able article communicated recently to the *Standard* narrated the failure of the carbon filaments and of the vacuous globes to stand permanent use. We now
8751 possess a careful scientific investigation into the economic value of the light. These results, though brief, are conclusive, and they confirm in every point the adverse criticisms which we published (*vide Engineering*, page 113, *ante*), when the authoritative article upon the light appeared last February. It appears that Mr. Edison, dissatisfied with the expressions of bitter disappointment heard on every hand, called in the aid of two prominent scientific gentlemen to carry out an independent investigation of his lamps and of
8752 the amount of power consumed by them in the production of light. These gentlemen were Professor H. A. Rowland, of the Johns Hopkins University—an excellent nomination—and Professor G. F. Barker, an out-and-out partisan of Edison (and professor of physics in the so-called University of Pennsylvania) and author of the work which so unworthily attempted to rob Professor Graham Bell of his laurels for the

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invention of the telephone. These gentlemen visited Menlo Park only to find the testing apparatus of a description too rough for use and the dynamometer hopelessly out of order. Contenting themselves, therefore, with an improvised laboratory experiment, they measured the light and the heat respectively emitted by two lamps coupled in series. Their calculations brought out the result that when the lamps were emitting from 10 to 13 candles' light, the energy
actually supplied by the steam engine to the generator 8754
was at the rate of one horse-power for 76 candles' power. When stronger currents were used, so as to make the lamps shine with about 30 candle power, the economy was greater, but the carbon filament was speedily destroyed. They wound up their report with the following conclusion: "Provided the lamp can be made either cheap enough or durable enough, there is no reasonable doubt of the practical success of the light, but this point will evidently require much
further experiment before the light can be pronounced 8755
practicable." This was the closing sentence of the article in *Silliman's Journal*, but we may record it as a fact in journalism that the *New York Herald*—the favored Edisonian organ—in avowedly quoting from *Silliman's Journal*, contrived to add the following sentence: "That Mr. Edison will finally overcome the difficulty, however, no one who knows him can doubt!" This, however, is not all. A much more satisfactory series of exact tests have been applied to
an Edison lamp with all the finest resources of the 8756
Stevens Institute; the actual resistance of the lamp and the strength of the current flowing being directly measured. These experiments were conducted by persons of no less eminence than Professor Morton and Professor Mayer. Their report on these experiments we hope to publish *in extenso* shortly; from it it would appear that though they found the efficiency of the lamp experimented with even greater than

8757 those tried by Professors Rowland and Barker, they emphatically conclude that the disadvantages of the system outweigh its advantages and its "relatively trifling economy disappears or ceases to have any controlling importance in the practical relations of the subject." The sounder judgment of American science, therefore, accords with that on this side of the Atlantic in its estimate of
8758 that which Mr. Edison modestly called "my discovery of the electric light."

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Defendant's Exhibit Edison Company's Notice No. 1. 8761

Office of
THE EDISON ELECTRIC LIGHT COMPANY.
65 Fifth Avenue.

New York, 188

This Company desires to call attention to the fact that it is the Owner, by proper assignments, of the entire right, title and interest in and to the following Letters Patent of the United States; and in and to the Inventions set forth and claimed therein. 8762

No.	Date.	Title	
214,636	April 22, 1879,	Electric lights.	
214,637	" 22 "	Thermal Regulators for Electric Lights.	
218,167	Aug. 5, "	Apparatus for Electric Lights.	8763
218,866	" 26, "	Electric Lighting Apparatus	
219,393	Sept. 9, "	Dynamo-Electric Machines.	
219,628	" 16, "	Electric Lights.	
222,881	Dec. 23, "	Magnet-Electric Machines.	
223,898	Jan. 27, 1880,	Electric Lamp.	
224,329	Feb. 10, "	Electric Lighting Apparatus.	
227,226	May 4, "	Safety-Conductor for Electric Lights.	8764
227,227	May 4, "	Electric Light.	
227,228	May 4, "	Electric Light.	
227,229	" 4, "	Electric Light.	
228,617	June 8, "	Brake for Electro-Magnetic Motors.	
230,255	July 20, "	Method of Manufacturing Electric Lamps.	

	No.	Date			Title
8765	237,732	Feb.	15,	1881	Electric Light.
	238,868	Mar.	15,	"	Manufacture of Carbons for Incandescent Electric Lamps.
	239,147	"	22,	"	System of Electric Lighting
	239,148	"	22,	"	Treating Carbons for Electric Lamps.
	239,149	"	22,	"	Incandescing Electric Lamp.
	239,150	"	22,	"	Electric Lamp.
8766	239,151	"	22,	"	Method of forming enlarged ends on Carbon Filaments.
	239,152	"	22,	"	System of Electric Lighting.
	239,153	"	22,	"	Electric Lamp.
	239,372	"	29,	"	Testing Electric Light Carbons.
	239,373	"	29,	"	Electric Lamp.
8767	239,374	"	29,	"	Regulating the Generation of Electric Currents.
	239,745	April	5,	"	Electric Lamps.
	240,678	"	26,	"	Webermeter.
	242,896	June	14,	"	Incandescent Eelectric Lamp.
	242,897	"	14,	"	Incandescent Electric Lamp
	242,898	"	14,	"	Magneto or Dynamo Electric Machine.
	242,899	"	14,	"	Electric Lighting.
8768	242,900	"	14,	"	Manufacturing Carbons for Electric lamps.
	242,901	"	14,	"	Electric Motor.
	248,416	Oct.	18,	"	Manufacture of Carbons for Electric Lamps.
	248,417	"	18,	"	Manufacturing Carbons for Electric Lights.
	248,418	"	18,	"	Electric Lamp.

No.	Date			Title	
248,419	Oct.	18,	1881	Electric Lamp.	8769
248,420	"	18,	"	Fixture and attachment for Electric Lamps.	
248,421	"	18,	"	Current Regulator for Dynamo Electric Machines.	
248,422	"	18,	"	System of Electric Lighting.	
248,423	"	18,	"	Carbonizer.	
248,424	"	18,	"	Fitting and Fixture for Electric Lamps.	
248,425	"	18,	"	Apparatus for producing High Vacuums.	8770
248,426	"	18,	"	Apparatus for Treating Carbons for Electric Lamps.	
248,427	"	18,	"	Apparatus for Treating Carbons for Electric Lamps.	
248,428,	"	18,	"	Manufacture of Incandescent Electric Lamps.	
248,429,	"	18,	"	Electric Motor.	
248,433	"	18,	"	Vacuum Apparatus.	
248,434	"	18,	"	Governor for Electric Engines.	8771
248,435	"	18,	"	Utilizing Electricity as a Motive Power.	
248,436	"	18,	"	Depositing Cell for Plating the Connections of Electric Lamps, etc.	
248,437	"	18,	"	Apparatus for treating Carbons for Electric Lamps.	
248,465	"	18,	"	Webermeter.	
251,536	Dec.	27,	"	Vacuum Pump.	8772
251,537	"	27,	"	Dynamo Electric Machine.	
251,538	"	27,	"	Electric Light.	
251,539	"	27,	"	Electric Lamp.	
251,540	"	27,	"	Carbon for Electric Lamps.	
251,541	"	27,	"	Electro-Magnetic Motor.	
251,542	"	27,	"	System of Electric Lighting.	

8773				
	251,543	Dec.	27, 1881	Electric Lamps.
	251,544	"	27, "	Manufacture of Electric Lamps.
	251,545	"	27, "	Electric Meter.
	251,546	"	27, "	Electric Lamp.
	251,547	"	27, "	Electrical Governor.
	251,548	"	27, "	Incandescent Electric Lamp.
8774	251,549	"	27, "	Electric Lamp and the Manufacture thereof.
	251,550	"	27, "	Magneto or Dynamo Electric Machine.
	251,551	"	27, "	System of Electric Lighting.
	251,552	"	27, "	Underground Conductor.
	251,553	"	27, "	Electric Chandelier.
	251,554	"	27, "	Electric Lamp and Socket or Holder.
8775	251,555	"	27, "	Regulator for Dynamo Electric Machines.
	251,556	"	27, "	Regulator for Magneto or Dynamo Electric Machines.
	251,557	"	27, "	Webermeter.
	251,558	"	27, "	Webermeter.
	251,559	"	27, "	Electrical Drop-Light.
	Design No. 12,631	"	27, "	Electric Lamps.

8776 The inventions therein claimed pertain to the Generation, Regulation, Distribution, Measurement and Utilization of Electric Currents for Light and Motive Power purposes.

They embrace improvements in Generators, in their arrangement and in means and methods for Regulating or Controlling their generative capacity; in Conductors for distributing the current; in "Safety Catches;" in Junction Boxes; in Meters; in Motors; in Incandescent Lamps and in Sockets, Brackets,

Chandeliers, Shades and other fittings or fixtures 8777
therefor; in arrangements of Conductors into Systems; in Systems of Lighting, and in other matters for a full knowledge of which reference may be had to the patents themselves.

The improvements in Lamps relate to Materials used therefor, to characteristics of the Incandescing Conductor, to the methods of treatment of the Materials, to means for such treatment, to methods of manufacture, to a complete lamp and to individual parts thereof, all as fully set forth in the patents relating thereto 8778
in the list above given.

This Company has been led to understand that other parties are now proposing to engage in the business of incandescent electric lighting, to manufacture and put upon the market incandescent lamps which in themselves, or in their manufacture, or in the arrangements for Generation, regulation, distribution, measurement and utilization (either or all) connected therewith, will infringe certain features covered by patents noted
in the list herewith given. 8779

Now, therefore, this Company gives notice to any and all such parties, and to any and all parties who may hereafter propose to enter upon the business of electric lighting by means of incandescent lamps, or furnishing electric power or lights; that if, in so doing, they infringe in any particular whatever, any of the patents hereinbefore noted, or any patent that may be hereafter owned by this Company, this Company will proceed against every such party for the full legal en-
forcement of each and every patent infringed. 8780

8781

Defendant's Exhibit Edison Company's Notice. No. 2.

Office of

THE EDISON ELECTRIC LIGHT COMPANY.

65 Fifth Avenue,

New York, November 9th, 1882.

8782 *The United States Electric Lighting Company,*

120 Broadway, New York.

In addition to the list of patents included in our notice served upon your company June 12th, 1882, of which we enclose duplicate herewith, we now beg to advise you that this company is the owner, by proper assignments, of the entire right, title and interest in and to the following additional letters patent of the United States; and in and to the inventions set forth and claimed therein.

8783

Number.	Date.	Title of Patent.
218,166	Aug. 5, 1879,	Improvement in Magneto-electric machines.
248,430	Oct. 18, 1881,	Electro-magnetic brake.
263,132	Aug. 22, 1882	Electro-magnetic railways.
263,133	" 22, "	Dynamo or magneto-electric machine.
263,134	" 22 "	Regulator for dynamo or magneto-electric machines.
8784 263,135	" 22 "	Electric lamp.
263,136	" 22 "	Regulator for dynamo or magneto electric machines.
263,137	" 22, "	Electric chandelier.
263,138	" 22, "	Electric arc light.
263,139	" 22, "	Manufacture of carbons for electric lamps.
263,140	" 22, "	Dynamo-electric machine.

263,141	Aug. 22, 1882	Straightening carbons of electric incandescent lamps	8785
263,142	" 22, "	Electrical distribution system.	
263,143	" 22, "	Magneto or dynamo-electric machine.	
263,144	" 22, "	Mold for carbonizing incandescents.	
263,145	" 22, "	Making incandescents.	
263,146	" 22, "	Dynamo or magneto-electric machines.	8786
263,147	" 22, "	Vacuum apparatus.	
263,148	" 22, "	Dynamo or magneto-electric machine.	
263,149	" 22, "	Commutator for dynamo or magneto-electric machines.	
263,150	" 22, "	Magneto or dynamo-electric machine.	
263,878	Sept. 5, "	Electric lamps.	
264,642	" 19, "	Electric distribution and translation system.	8787
264,643	" 19, "	Magneto-electric machine.	
264,645	" 19, "	System of conductors for the distribution of electricity.	
264,646	" 19, "	Dynamo or magneto-electric machine.	
264,647	" 19, "	Dynamo or magneto-electric machine.	
264,648	" 19, "	Dynamo or magneto-electric machine.	8788
264,649	" 19, "	Dynamo or magneto-electric machine.	
264,650	" 19, "	Manufacture of incandescing electric lamps.	
264,651	" 19, "	Incandescent electric lamp.	
264,652	" 19, "	Incandescent electric lamp.	
264,653	" 19, "	Incandescent electric lamp.	
264,654	" 19, "	Incandescent electric lamp.	

8789

	264,655	Aug. 19, 1882	Incandescent Electric Lamp.
	264,656	" 19, "	Incandescent Electric Lamp.
	264,657	" 19, "	Incandescent Electric Lamp.
	264,658	" 19, "	Regulator for dynamo-electric machines.
	264,659	" 19, "	Regulator for dynamo-electric machines.
	264,660	" 19, "	Regulator for dynamo-electric machines.
8790	264,661	" 19, "	Regulator for dynamo-electric machines.
	264,662	" 19, "	Regulator for dynamo-electric machines.
	264,663	" 19, "	Regulator for dynamo-electric machines.
	264,664	" 19, "	Regulator for dynamo-electric machines.
	264,665	" 19, "	Regulator for dynamo-electric machines.
8791	264,666	" 19, "	Regulator for dynamo-electric machines
	264,667	" 19, "	Regulator for dynamo-electric machines.
	264,668	" 19, "	Regulator for dynamo-electric machines.
	264,669	" 19, "	Regulator for dynamo-electric machines.
	264,670	" 19, "	Regulator for dynamo-electric machines.
8792	264,671	" 19, "	Regulator for dynamo-electric machines.
	264,672	" 19, "	Regulator for dynamo-electric machines.
	264,673	" 19, "	Regulator for dynamo-electric machines.
	264,698	" 19, "	Electric lamp.
	264,737	" 19, "	Incandescing electric lamp.

8793

265,311	Oct. 3, "	Electric lamps and holders for same.	
265,774	" 10, "	Method of maintaining temperature in Webermeters.	
265,775	" 10, "	Electric arc light.	
265,776	" 10, "	Electric lighting system.	
265,777	" 10, "	Method of treating carbons for electric lamps.	
265,778	" 10, "	Electro-magnetic railway engines.	8794
265,779	" 10, "	Regulator for dynamo-electric machines.	
265,780	" 10, "	Regulator for dynamo-electric machines.	
265,781	" 10, "	Regulator for dynamo-electric machines.	
265,782	" 10, "	Regulator for dynamo-electric machines.	
265,783	" 10, "	Regulator for dynamo-electric machines.	8795
265,784	" 10, "	Regulator for dynamo-electric machines.	
265,785	" 10, "	Dynamo-electric machine.	
265,786	" 10, "	Apparatus for the electrical transmission of power.	
265,858	" 10, "	Regulator for dynamo-electric machines.	
265,859	" 10, "	Regulator for dynamo-electric machines.	
266,447	" 24, "	Electric incandescent lamp.	8796
266,588	" 24, "	Vacuum apparatus.	

The inventions therein claimed pertain to the generation, regulation, distribution, measurement and utilization of electric currents for light and motive power purposes.

They embrace improvements in generators, in their arrangement and in means and methods for regulating

8797 or controlling their generative capacity; in conductors for distributing the current; in "safety catches;" in junction boxes; in meters; in motors; in incandescent lamps, and in sockets, brackets, chandeliers, shades and other fittings or fixtures therefor; in arrangement of conductors into systems; in systems of lighting and in other matters, for a full knowledge of which reference may be had to the patents themselves.

8798 The improvements in lamps relate to materials used therefor, to characteristics of the incandescing conductor, to the methods of treatment of the materials, to means for such treatment, to methods of manufacture, to a complete lamp and to individual parts thereof, all as fully set forth in the patents relating thereto in the list above given.

This company has been led to understand that other parties are now proposing to engage in the business of incandescent electric lighting, to manufacture and put
8799 upon the market incandescent electric lamps which in themselves, or in their manufacture, or in the arrangements for generation, regulation, distribution, measurement and utilization (either or all) connected therewith, will infringe certain features covered by patents noted in the list herewith given.

Now, therefore, this company gives notice to any and all such parties and to any and all parties who may hereafter propose to enter upon the business of electric lighting by means of incandescent lamps, or
8800 of furnishing electric power or lights; that if, in so doing, they infringe in any particular whatever, any of the patents hereinbefore noted, or any patent that may be hereafter owned by this company, this company will proceed against every such party for the full legal enforcement of each and every patent infringed.

THE EDISON ELECTRIC LIGHT CO.,
by C. GODDARD,
Sec'y.

Defendants Exhibit File Wrapper and Contents of Patent in Suit. 8801

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE.

To all Persons to whom these Presents shall come, Greeting:

8802 This is to certify, that the annexed is a true copy from the Records of this Office, of the File Wrapper and Contents in the matter of the Letters Patent granted Thomas A. Edison, January 27, 1880, Number 223,898, for Improvement in Electric Lamp.

In testimony whereof I, C. E. Mitchell, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this 10th day of April, in the
[SEAL.] year of our Lord one thousand eight 8803
hundred and ninety, and of the Independence of the United States the one hundred and fourteenth.

C. E. MITCHELL,
Commissioner.

P. O. Box 4,689.

NEW YORK, Nov. 3rd, 1879.

HONORABLE COMMISSIONER OF PATENTS:

SIR: I inclose check for thirty dollars fees on the 8804
applications for Patents sent herewith, of Otto Heikel

Magnetic Electric Machine.		$15.
T. A. EDISON,	Electric Lamps,	15.
		30.

Respectfully yours,
LEMUEL W. SERRELL,
per C. H. SMITH.

8805

TO THE HONORABLE COMMISSIONER OF PATENTS:

Your Petitioner, Thomas A. Edison, of Menlo Park in the State of New Jersey, prays that Letters Patent may be granted to him for the invention of an Improvement in Electric Lamps, and in the method of manufacturing the same set forth in the annexed specification. (Case No. 186).

And further prays that you will recognize Lemuel W. Serrell, of the City of New York, N. Y., as his At-
8806 torney, with full power of substitution and revocation to prosecute this application, to make alterations and amendments therein, to receive the Patent, and to transact all business in the Patent Office connected therewith.

THOMAS A. EDISON.

Menlo Park, N. J., }
Nov. 1st, 1879. }

UNITED STATES OF AMERICA.

8807 STATE OF NEW JERSEY, }
County of Middlesex, } ss.:

On this first day of November in the year one thousand eight hundred and seventy-nine before the subscriber, a Notary Public in and for said State, personally appeared the within named Thomas A. Edison, and made solemn oath that he verily believes himself to be the original and first inventor of the within described Imp't in Electric Lamps, and in the method of manufacturing the same, and that he does
8808 not know and does not believe that the same was ever before known or used, and that he is a citizen of the United States, and a resident of Menlo Park, N. J.

THOMAS A. EDISON.

Sworn to before me, the day and year above written.

STOCKTON L. GRIFFIN,
Notary Public.

{L. S.}

8809

To all whom it may concern:

Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, have invented an Improvement in Electric Lamps, and in the method of manufacturing the same, of which the following is a specification.

The object of this invention is to produce electric lamps giving light by incandescence, which lamps shall have high resistance, so as to allow of the practical subdivision of the electric light. 8810

The invention consists in a light giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place.

The invention further consists in placing such burner of great resistance in a nearly perfect vacuum, to prevent oxidation and injury to the conductor by the atmosphere. The current is conducted into the 8811
vacuum-bulb through platina wires sealed into the glass.

The invention further consists in the method of manufacturing carbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading wires and the carbon conductor.

Heretofore light by incandescence has been obtained from rods of carbon of one to four ohms 8812
resistance placed in closed vessels, in which the atmospheric air has been replaced by gases that do not combine chemically with the carbon. The vessel holding the burner has been composed of glass cemented to a metallic base. The connection between the leading wires and the carbon has been obtained by clamping the carbon to the metal. The leading wires have always been large, so that their resistance shall be many times less than the burner, and, in general,

8813 the attempts of previous persons has been to reduce the resistance of the carbon rod.

The disadvantages of following this practice are, that a lamp having but one to four ohms resistance cannot be worked to great numbers in multiple arc without the employment of main conductors of enormous dimensions; that owing to the low resistance of the lamp, the leading wires must be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and
8814 are cemented, hence the carbon is consumed, because there must be almost a perfect vacuum to render the carbon stable, especially when such carbon is small in mass and high in electrical resistance.

The use of a gas in the receiver at the atmospheric pressure, although not attacking the carbon, serves to destroy it in time by "air-washing," or the attrition produced by the rapid passage of the air over the slightly-coherent highly-heated surface of the carbon.

8815 I have reversed this practice. I have discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from one hundred to five hundred ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral and carbonized, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled, as much as two thousand
8816 ohms resistance may be obtained without presenting a radiating surface greater than 3-16 of an inch; that if such fibrous material be rubbed with a plastic composed of lamp-black and tar, its resistance may be made high or low according to the amount of lamp-black placed upon it; that carbon filaments may be made by a combination of tar and lamp-black, the latter being previously ignited in a

closed crucible for several hours, and afterwards moistened and kneaded until it assumes the consistency of thick putty. Small pieces of this material may be rolled out in the form of wire as small as 7-1000 of an inch in diameter, and over a foot in length, and the same may be coated with a non-conducting, non-carbonizing substance and wound on a bobbin, or as a spiral, and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form. 8817

All these forms are fragile and cannot be clamped to the leading wires with sufficient force to ensure good contact and prevent heating. I have discovered that if platinum wires are used and the plastic lamp-black and tar material be moulded around it, in the act of carbonization there is an intimate union by combination and by pressure between the carbon and platina, and nearly perfect contact is obtained without the necessity of clamps, hence the burner and the leading wires are connected to the carbon ready to be placed in the vacuum-bulb. 8818

When fibrous material is used, the plastic lamp-black and tar is used to secure it to the platina before carbonizing. 8819

By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading wires as they will have a small resistance compared to the burner, and hence will not heat and crack the sealed vacuum bulb. Platina can only be used, as its expansion is nearly the same as that of glass. By using a considerable length of carbon wire and coiling it in such a manner that only a small portion of its entire surface radiates light, I can raise the specific heat of the whole and thus prevent the rapid reception and disappearance of the light, which on a plain wire is prejudicial, as it shows the least unsteadiness of the current by the flickering of the light; but if the current is steady the defect does not show. 8820

Substitute "A" per Amd't Dec. 16, 1879.

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I have carbonized and used cotton and linen thread, wood splints, papers coiled in various ways, also lamp-black, plumbago and carbon in various forms, mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameters. Each wire, however, is to be uniform in size throughout.

If the carbon thread is liable to be distorted during carbonization, it is to be coiled between a helix of
8822 copper wire. The ends of the carbon or filament are secured to the platina wires by plastic carbonizable material, and the whole placed in the carbonizing-chamber. The copper which has served to prevent distortion of the ~~copper~~ carbon thread is afterwards eaten away by nitric acid, and the spiral soaked in water and then dried and placed on the glass holder, and a glass bulb blown over the whole, with a leading tube for exhaustion by a mercury-pump. This tube, when a high vacuum has been reached, is hermetically
8823 sealed.

Insert per Amd't Nov. 13, '79.

With substances which are not greatly distorted in carbonizing, they may be coated with a non-conducting, non-carbonizable substance, which allows one coil or turn of the carbon to rest upon and be supported by the other.

In the drawings, Figure 1 shows the lamp sectionally. *A* is the carbon spiral or thread—*c c*[1] are the thickened ends of the spiral, formed of the plastic compound of lamp black and tar, *d*, *d*[1], are the platina
8824 wires. *h. h.* are the clamps which serve to connect the platina wires cemented in the carbon with the leading wires *x. x*, sealed in the glass vacuum-bulb. *e e*, are copper wires connected just outside the bulb to the wires *x*, *x*. *m*, is the tube, (shown by dotted lines), leading to the vacuum pump, which, after exhaustion is hermetically sealed and the surplus removed. Fig. 2 represents the plastic material before being wound into a spiral. Fig. 3 shows the spiral after carbonization ready to have a bulb blown over it.

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I claim as my invention,

First, An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires, as set forth.

Second, The combination of carbon filaments within a receiver made entirely of glass through which the leading wires pass, and from which receiver the air is exhausted for the purposes set forth. 8826

Third, A coiled carbon filament or strip arranged in such a manner that only a portion of the surface of such carbon conductor shall radiate light as set forth.

Fourth, The method herein described of securing the platina contact wires to the carbon filament and carbonizing of the whole in a closed chamber, substantially as set forth. 8827

Signed by me this 1st day of November, A. D., 1879.

Witnesses:
S. L. Griffin,
John F. Randolph.

Thomas A. Edison.

[Endorsed: Case No. 186 dated Nov. 1, 1879; Thomas A. Edison, Impt. in Electric Lamps, and in the method of manufacturing the same. U. S. Patent Office Nov. 4, '79.]

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NEW YORK, November 12th, 1879.

HON. COMMISSIONER OF PATENTS:

SIR: I hereby amend the specification of my application for Letters Patent for Improvement in Electric Lamps, and in the method of manufacturing the same, filed November 4th, 1879, Case No. 186, as follows:

By erasing the word "copper," line 9, paragraph 15, and inserting the word "carbon" in place thereof.

8830 Respectfully yours,

THOMAS A. EDISON,
per Lemuel W. Serrell,
Atty.

[Endorsed No. 1 Amendment Nov. 13th, 1879. U.S. Patent Office, Nov. 13, 1879.]

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Room No. — 8833

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., Dec. 5, 1879.

T. A. EDISON, Case 186.
Care L. W. Serrell,
Box 4,689, N. Y. City.
Electric Lamps, Filed Nov. 4, 79.

Claim 2 seems imperfect in form, the combination consists wholly of filaments. 8834

Subject matter of claim 3 should be amplified in the specification as it is not at present understood by the examiner.

H. C. TOWNSEND, Exr.
C. L. BUCKINGHAM, Asst.

[Endorsed: No. 2-Rejection December 5, 79.]

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NEW YORK, Dec 15th, 1879.

HON. COMMISSIONER OF PATENTS—

SIR: In the matter of my application for a patent on Electric Lamps (case 186) filed Nov. 4th, 1879, I hereby *amend* the *specification* by erasing that portion of paragraph 13, commencing "*By using a considerable,*" down to and including the words "*specific heat of the whole,*" and substituting the following:

By using a considerable length of carbon wire and
8838 coiling it, the exterior, which is only a small portion of its entire surface, will form the principal radiating-surface; hence I am able to raise the specific heat of the whole of the carbon,"

By erasing claims 2 and 3, and substituting the following:

Second. The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass, and from which receiver the air is exhausted for the purposes set forth.

8839

Third. A carbon filament or strip coiled and connected to electric conductors, so that only a portion of the surface of such carbon conductor shall be exposed for radiating light, as set forth."

Respectfully yours,
THOS A. EDISON,
per Lemuel W. Serrell,
Atty.

8840 [Endorsement: [illegible] "A" "B" 3 Amendment Dec. 16, 8879. Thos. A. Edison, Electric Lamp. Amendment for Room No. 118. U. S. Patent Office Dec. 16 1879.]

DEPARTMENT OF THE INTERIOR. 8841

U. S. PATENT OFFICE,
WASHINGTON, D. C., Dec. 22, 1879.

THOS. A. EDISON,

Care L. W. SERRELL,

Box 4,689, N. Y. City.

SIR: Your application for a Patent for an Improvement in Electric Lamps filed Nov. 4, 1879, has been 8842
examined and allowed.

The final fee, Twenty Dollars, must be paid, and the Letters Patent bear date as of a day not later than six months from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application with additional fees, under the provisions of Section 4,897, Revised Statutes. The office aims to deliver patents upon the day 8845
of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least twenty days prior to the conclusion of the six months allowed them by law. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, dis- 8844
tinctly and plainly written, the name of the inventor and title of invention as above given, date of allowance, (which is the date of this circular), date of filing, and, if assigned, the names of the assignees.

8845 If you desire to have the patent issue to assignees an assignment containing a request to that effect, together with the fee for recording the same, must be filed in this Office on or before the date of payment of final fee.

Additional copies of Specifications and Drawings will be charged for at the following rates: Single copies uncertified, 25 cents; twenty copies or more, 10 cents each. The money should accompany the order.

8846 Very respectfully,

H. E. PAINE,

Commissioner of Patents.

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Memorandum 8849

of

Fee Paid at U. S. Patent Office.

Inventor,

Thomas A. Edison.

Patent to be issued to Thomas A. Edison.

Name of Invention, as allowed:

Case No. 186. 8850

Electric Lamps.

Date of Payment,
January 8, 1880,
and Ordered paid by Telegraph Jan. 8, 80.

Fee:

$20.

Solicitor,

Lemuel W. Serrell. 8851

Date of Circular of Allowance.

Dec. 22d, 1879.

Send Patent to

L. W. Serrell,

Box 4,689.

N. Y. City.

8852

8853 The Western Union Telegraph Company, Dated New York, Jan. 8th, 1880. Received at Dept. Int. Jan. 8th, 12.20.

To Hon. Comm'r. of Patents.

Wash'tn, D. C.

Please pay balance Edison. Light case, one hundred and eighty-six. Charge my account.
Check by mail.

8854 17 Paid. L. W. Serrell.

[Endorsed—U. S. Patent Office, Jan. 8, 1881.]

Room No. 91. Interference.

DEPARTMENT OF THE INTERIOR.

8855 United States Patent Office,
Washington, D. C., Dec. 8th, 1881.

[Stamped—U. S. Patent Office, Dec. 10, 84, for Interference.]

Thomas A. Edison,

Cr Lemuel W. Serrell,

Box 4,689, New York City.

Please find below a copy of a communication from the Examiner concerning your patent for Electric
8856 Lamps, No. 223,898, Jan. 27, 1880, filed Nov. 4, 1879.

Very respectfully,

E. M. Marble,
Commissioner of Patents.

Room No. 91. 8857

Your case, above referred to, is adjudged to interfere with another hereafter specified, and the question of priority will be determined in conformity with the Rules.

The statement demanded by Rule 105, must be sealed up and filed on or before the 12th day of Jany., 1882, with the subject of the invention, and name of party filing it, indorsed on the envelope.
The subject matter involved in the interference is: 8858
"An electric lamp for giving light by incandescence consisting of a strip or filament of carbon of high resistance enclosed within an exhausted receiver made entirely of glass and attached to metal wires passing through and sealed into the glass as set forth."

The same being substantially embraced in your second claim, and the only claim of the interfering case.

The interfering case above referred to is the application of Walter K. Freeman, of Brooklyn, N. Y., for 8859
Electric Lamps filed July 25, 1881, No. 35,501.

Marcellus Bailey, Associate Attorney.

Washington, D. C.

Freeman, Ex.

[Endorsed: $\frac{10}{35}$.—T. A. Edison, Dec. 8, 1881; Intf.]

8860

8853 The Western Union Telegraph Company, Dated New York, Jan. 8th, 1880. Received at Dept. Int. Jan. 8th, 12.20.

To Hon. Comm'r. of Patents.

Wash'tn, D. C.

Please pay balance Edison. Light case, one hundred and eighty-six. Charge my account.
Check by mail.

8854 17 Paid. L. W. Serrell.

[Endorsed—U. S. Patent Office, Jan. 8, 1881.]

Room No. 91.

Interference.

DEPARTMENT OF THE INTERIOR.

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Washington, D. C., Dec. 8th, 1881.

[Stamped—U. S. Patent Office, Dec. 10, 84, for Interference.]

Thomas A. Edison,

Cr Lemuel W. Serrell,

Box 4,689, New York City.

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"An electric lamp for giving light by incandescence consisting of a strip or filament of carbon of high resistance enclosed within an exhausted receiver made entirely of glass and attached to metal wires passing through and sealed into the glass as set forth."

The same being substantially embraced in your second claim, and the only claim of the interfering case.

The interfering case above referred to is the appli- 8859
cation of Walter K. Freeman, of Brooklyn, N. Y., for Electric Lamps filed July 25, 1881, No. 35,591.

Marcellus Bailey, Associate Attorney.

Washington, D. C.

Freeman, Ex.

[Endorsed: 10/15.—T. A. Edison, Dec. 8, 1881; Intf.]

8860

8861 To the Commissioner of Patents—

The undersigned having on or about February 12, 1880, acquired by assignment the entire interest in the patent of T. A. Edison for an Electric Lamp, No. 223,-898, dated January 27, 1880, the application for which was filed Nov. 4, 1879, and an interference having been declared between the above patent, and the application of Walter K. Freeman filed July 25, 1881, hereby appoints Messrs. Dyer and Wilber of Wash-
8862 ington, D. C., its attorneys in this matter with full power of substitution and revocation.

The Edison Electric Light Co.
By S. B. Eaton,
Vice Pres.

In presence of
Wm. H. Meadowcroft.

[Endorsed: Power of Atty., Dyer & Wilber. U. S. Patent Office, Jan. 13, 1882.]

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Z. F. Wilber, 8865

No. 65 Fifth Avenue,

New York, Jany. 19th, 1882.

In the United States Patent Office.

In Re-Interference:

Freeman vs. Edison. } Incandescent Electric Lamps. 8866

Hon Comm'r Patents:

In the above noted cause please recognize F. S. Betts, Esq., No. 120 Broadway, New York City as Associate Attorney.

Please, in the future, address all correspondence re- 8867
lating to the cause to him.

Dyer & Wilber,
Attys. for Edison.

[Endorsed: Asso. Power of Atty. to F. S. Betts. U. S. Patent Office, Jan 20, 1882.]

See power of
Atty. to
Z. F. Wilber, 8868
on file in the
Chief Clerk's
room.

[Endorsed U. S. Patent Office, Feb. 7 1882.]

8869

Patent 223,898, Jan. 27th, 1880, Edison's—in interference Dec. 8th, 1881 (Freeman *vs.* Edison) Improvement in Electric Lamps.

To the Commissioner of Patents:

In the above-named interference, I hereby revoke the power of attorney given by me to Z. F. Wilber, or to Dyer & Wilber, and appoint instead as my attorney, Richard N. Dyer, of Menlo Park, New Jersey with full power of substitution and revocation, to
8870 prosecute said interference, and to transact all business in the Patent Office connected therewith.

Signed at Menlo Park, N. J., Aug. 8, 1882.

Thos. A. Edison.

The undersigned, The Edison Electric Light Company, assignee of the above patent, hereby concurs, and joins in the foregoing power of attorney.

Signed at New York City, August 10, 1882,

The Edison Electric Light Company.

8871 By S. B. Eaton,

Vice President.

[Endorsed: Power of Attorney and Revocation. U. S. Patent Office Aug 14, 1882]

New York City, Nov. 17, 1883.

Hon Commissioner of Patents:

Sir: I enclose herewith Letters Patent of Thomas A. Edison No. 223,898 with a petition signed by Mr. Edison and concurred in by the Edison Electric
8872 Light Co. the assignee of the patent for the correction of such Letters Patent, Kindly enter my appearance for the petitioners in this case and address correspondence relating thereto to me.

Respectfully

Rich'd N Dyer

[Endorsed; Issue and Gazette Division B; Corrected L. P. returned Dec. 18, 1883. Patent Office Nov. 19, 1883 U. S. A.]

8873

To the Commissioner of Patents:

Your petitioner, Thomas A. Edison, a citizen of the United States, residing at Menlo Park, in the County of Middlesex and State of New Jersey, respectfully represents:

(1). That on or about November 14th, 1879, he applied for Letters Patent of the United States, for an improvement in Electric Lamps, and that Letters
Patent for said improvement, numbered 223,898 were 8874
issued to him January 27th, 1880 of which Letters Patent, The Edison Electric Light Company, a corporation existing under the laws of the State of New York, in whose behalf and by whose assent this petition is presented, is now sole owner by assignment.

(2). That while said application was pending in the United States Patent Office, he applied for and obtained Letters Patent for the same invention in several foreign countries, viz.: 8875

British Patent,	No. 4,576,	dated	Nov.	10th, 1879.
Canadian "	" 10,654,	"	"	17th, "
Belgian "	" 49,884,	"	"	29th, "
Italian "	"	"	Dec.	6th, "
French "	" 133,756	"	Jan.	20th, 1880

And that no other patents were granted upon the invention in foreign countries before the grant of said U. S. Patent, No. 223,898.

(3.) That at the time of filing said United States ap- 8876
plication, no foreign patents had been applied for or granted upon the said invention, and that at the time during which his application was pending in the United States Patent Office, he was advised that the rules and practice of the office under the prevailing construction of Section 4,887, Revised Statutes, did not require an applicant to acknowledge during the pendence of his application, a foreign patent applied

8877 for, and granted subsequent to the filing of such application; and that he therefore did not acknowledge the above-named foreign patents, and the United States Letters Patent were granted to him, unlimited, for the full term of seventeen years.

(4). That he has recently been advised that the law has been construed by recent decisions contrary to the practice prevailing at the time mentioned; and he has
8878 further been advised that the said Lettters Patent when issued, should have been limited upon their face to the term of the foreign patent, having the shortest term, dated prior to the date of the United States Patent.

Your petitioner, therefore, tenders the said United States Letters Patent No. 223,898, to the Commissioner of Patents, and requests that they may be corrected according to the provisions of the first clause of Rule 164.

8879

THOMAS A. EDISON.

State of New York }
COUNTY OF NEW YORK, } ss.

Thomas A. Edison, the above named petitioner, being duly sworn, deposes and says that the statements made in the foregoing petition are true to the best of his information and belief.

THOMAS A. EDISON.

Subscribed and sworn to before me this 15th day of
8880 November, 1883.

WM. H. MEADOWCROFT,
[L. S.] Notary Public.
New York County.

The undersigned, the Edison Electric Light Company, hereby consents to and concurs in the above petition.

The Edison Electric Light Company,
by S. B. EATON,
President.

8881

STATE OF NEW YORK, }
City and County of New York } ss.:

On this 15th day of November in the year 1883, before me personally appeared S. B. Eaton, the President of The Edison Electric Light Company, of the City of New York, with whom I am personally acquainted, who, being by me duly sworn, said that he resided in the City of New York; that he was President of the Edison Electric Light Company; and that he signed his name to the foregoing petition as President of said Company by order of the Board of Directors of said Company. 8882

WM. H. MEADOWCROFT,
[L. S.] Notary Public,
New York County.

[Endorsed: Petition for correction of Letters Patent of T. A. Edison; No. 223,898. Richard N. Dyer, 65 Fifth Avenue, New York.

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DEPARTMENT OF THE INTERIOR.

PATENT OFFICE.

Nov. 20, 1883.

EXR. KINTNER :

Is the case still held for interference? He now wants a certificate of limitation. Can you let me have the file.

J. W. BABSON,

8886 Chief of Issue and Gazette Division.

Still in interference. Filed with Intf. Ex. C. J. K.

[Endorsed, Ex. McArthur;—Could you let me have the file long enough to attach a certificate of limitation. Respectfully ;

J. W. BABSON: Dec. 17 '83.

1879. Freeman 140-13.

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No. 223,898. (No. 186.)

Thomas A. Edison,
of Menlo Park,

County of
State of New Jersey.

Electric Lamps.

Rec'd	Nov.	4,	1879. 8890
Petition	"	"	"
Affidavit	"	"	"
Specification	"	"	"
Drawing	"	"	"
Model	"	"	"
Crt. dep.			
Cash $15,	Nov. 4,		1879.

Add'l Fee Cert.
" " Cash $20, Jany. 8, 1880.
Examined Dec. 19, 1879. H. C. Townsend. 8891
Issue Dec. 22, 1879, Arthur W. Crossley.
Patented Jany. 27, 1880.
Circular, Dec. 22, '79.

LEMUEL W. SERRELL,
Box 4,689, New York City.

DYER & WILBER. Present.
F. S. BETTS, 120 Broadway, N. Y. City.

Certificate of Correction, Issued Dec. 18, 1883.

R. N. DYER,
Menlo Park, 8892
New Jersey.

8893

1879.

CONTENTS.

Application papers.

1 Amdt. Nov. 13th 1879.

2 Rej. Dec. 5, '79.

8894 3 Amdt. Dec. 15, '79 "A-B."

4 Brief, Dec. 19, '79.

5 Dec. 8, '81 x 38,501.

12 36 Electricity.

13 Electric Lights.

8895 Title.

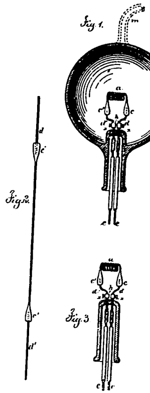
Improvements in Electric Lamps.

Exd. M. McK.
J. A. W.

8896

T. A. EDISON.
Electric-Lamp.

No. 223,898. Patented Jan. 27, 1880.



Witnesses
Chas. H. Smith
Geo. T. Pinckney

Inventor
Thomas A. Edison
per Lemuel W. Serrell
atty

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 223,898, dated January 27, 1880.

Application filed November 4, 1879.

To all whom it may concern:

Be it known that I, THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America, have invented an Improvement in Electric Lamps, and in the method of manufacturing the same, (Case No. 186,) of which the following is a specification.

The object of this invention is to produce electric lamps giving light by incandescence, which lamps shall have high resistance, so as to allow of the practical subdivision of the electric light.

The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place.

The invention further consists in placing such burner of great resistance in a nearly-perfect vacuum, to prevent oxidation and injury to the conductor by the atmosphere. The current is conducted into the vacuum-bulb through platina wires sealed into the glass.

The invention further consists in the method of manufacturing carbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading-wires and the carbon conductor.

Heretofore light by incandescence has been obtained from rods of carbon of one to four ohms resistance, placed in closed vessels, in which the atmospheric air has been replaced by gases that do not combine chemically with the carbon. The vessel holding the burner has been composed of glass cemented to a metallic base. The connection between the leading-wires and the carbon has been obtained by clamping the carbon to the metal. The leading-wires have always been large, so that their resistance shall be many times less than the burner, and, in general, the attempts of previous persons have been to reduce the resistance of the carbon rod. The disadvantages of following this practice are, that a lamp having but one to four ohms resistance cannot be worked in great numbers in multiple arc without the employment of main conductors of enormous dimensions; that, owing to the low resistance of the lamp, the leading-wires must be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and are cemented; hence the carbon is consumed, because there must be almost a perfect vacuum to render the carbon stable, especially when such carbon is small in mass and high in electrical resistance.

The use of a gas in the receiver at the atmospheric pressure, although not attacking the carbon, serves to destroy it in time by "air-washing," or the attrition produced by the rapid passage of the air over the slightly-coherent highly-heated surface of the carbon. I have reversed this practice. I have discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from one hundred to five hundred ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral and carbonized, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled, as much as two thousand ohms resistance may be obtained without presenting a radiating-surface greater than three-sixteenths of an inch; that if such fibrous material be rubbed with a plastic composed of lamp-black and tar, its resistance may be made high or low, according to the amount of lamp-black placed upon it; that carbon filaments may be made by a combination of tar and lamp-black, the latter being previously ignited in a closed crucible for several hours and afterward moistened and kneaded until it assumes the consistency of thick putty. Small pieces of this material may be rolled out in the form of wire as small as seven-one-thousandths of an inch in diameter and over a foot in length, and the same may be coated with a non-conducting non carbonizing substance and wound on a bobbin, or as a spiral, and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form.

All these forms are fragile and cannot be clamped to the leading-wires with sufficient force to insure good contact and prevent heating I have discovered that if platinum wires are used and the plastic lamp-black and tar material be molded around it in the act of car-

bonization there is an intimate union by combination and by pressure between the carbon and platina, and nearly perfect contact is obtained without the necessity of clamps; hence the burner and the leading-wires are connected to the carbon ready to be placed in the vacuum-bulb.

When fibrous material is used the plastic lamp-black and tar are used to secure it to the platina before carbonizing.

By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading-wires, as they will have a small resistance compared to the burner, and hence will not heat and crack the sealed vacuum-bulb. Platina can only be used, as its expansion is nearly the same as that of glass.

By using a considerable length of carbon wire and coiling it the exterior, which is only a small portion of its entire surface, will form the principal radiating-surface; hence I am able to raise the specific heat of the whole of the carbon, and thus prevent the rapid reception and disappearance of the light, which on a plain wire is prejudicial, as it shows the least unsteadiness of the current by the flickering of the light; but if the current is steady the defect does not show.

I have carbonized and used cotton and linen thread, wood splints, papers coiled in various ways, also lamp-black, plumbago, and carbon in various forms, mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameters. Each wire, however, is to be uniform in size throughout.

If the carbon thread is liable to be distorted during carbonization it is to be coiled between a helix of copper wire. The ends of the carbon or filament are secured to the platina leading-wires by plastic carbonizable material, and the whole placed in the carbonizing-chamber. The copper, which has served to prevent distortion of the carbon thread, is afterward eaten away by nitric acid, and the spiral soaked in water, and then dried and placed on the glass holder, and a glass bulb blown over the whole, with a leading-tube for exhaustion by a mercury-pump. This tube, when a high vacuum has been reached, is hermetically sealed.

With substances which are not greatly distorted in carbonizing, they may be coated with a non-conducting non-carbonizable substance, which allows one coil or turn of the carbon to rest upon and be supported by the other.

In the drawings, Figure 1 shows the lamp sectionally. *a* is the carbon spiral or thread. *c c'* are the thickened ends of the spiral, formed of the plastic compound of lamp-black and tar. *d d'* are the platina wires. *h h* are the clamps, which serve to connect the platina wires, cemented in the carbon, with the leading-wires *x x*, sealed in the glass vacuum-bulb. *e e* are copper wires, connected just outside the bulb to the wires *x x*. *m* is the tube (shown by dotted lines) leading to the vacuum-pump, which, after exhaustion, is hermetically sealed and the surplus removed.

Fig. 2 represents the plastic material before being wound into a spiral.

Fig. 3 shows the spiral after carbonization, ready to have a bulb blown over it.

I claim as my invention—

1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires, as set forth.

2. The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass, and from which receiver the air is exhausted, for the purposes set forth.

3. A carbon filament or strip coiled and connected to electric conductors so that only a portion of the surface of such carbon conductors shall be exposed for radiating light, as set forth.

4. The method herein described of securing the platina contact-wires to the carbon filament and carbonizing of the whole in a closed chamber, substantially as set forth.

Signed by me this 1st day of November, A. D. 1879.

THOMAS A. EDISON.

Witnesses:
S. L. GRIFFIN,
JOHN F. RANDOLPH.

Correction in Letters Patent No. 223,898.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
Washington, D. C., December 18, 1883.

In compliance with the request of the party in interest, Letters Patent No. 223,898, granted January 27, 1880, to Thomas A. Edison, of Menlo Park, New Jersey, for an improvement in "Electric Lamps," is hereby limited so as to expire at the same time with the patent of the following named, having the shortest time to run, viz: British patent dated November 10, 1879, No. 4,576; Canadian patent dated November 17, 1879, No. 10,654; Belgian patent dated November 29, 1879, No. 49,884; Italian patent dated December 6, 1879, and French patent dated January 20, 1880, No. 133,756.

It is hereby certified that the proper entries and corrections have been made in the files and records of the Patent Office.

This amendment is made that the United States Patent may conform to the provisions of Section 4887 of the Revised Statutes.

Approved:
M. L. JOSLYN,
Acting Secretary of the Interior.

BENJ. BUTTERWORTH,
Commissioner of Patents.

Defendant's Exhibit Patent Head of Patent in Suit.

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

To all persons to whom these Presents shall come, Greeting.

This is to certify that the annexed is a true copy from the files of this office of the letters patent granted Thomas A. Edison, January 27th, 1880, No. 223,898, for improvement in electric lamp.

In testimony whereof I, C. E. Mitchell, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this 11th day of April, in the year of our Lord one thousand eight hundred and ninety, and of the Independence of the United States the one hundred and fourteenth.

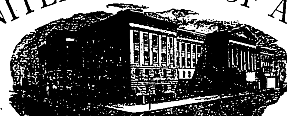
[SEAL.]

C. E. MITCHELL,
Commissioner.

(2–155.)

No. 223,898.

THE UNITED STATES OF AMERICA.



To all to whom these Presents shall come:

Whereas, Thomas A. Edison

Menlo Park, of New Jersey

has presented to the Commissioner of Patents a petition praying for the grant of LETTERS PATENT for an alleged new and useful

Improvements in Electric Lamps

a description of which invention is contained in the Specification, of which a copy is hereunto annexed and made a part hereof, and has complied with the various requirements of Law in such case made and provided; and

Whereas, upon due examination made the said Claimant is adjudged to be justly entitled to a Patent under the Law;

Now, therefore, these LETTERS PATENT are to grant unto the said Thomas A. Edison, his heirs or assigns for the term of seventeen years from the twenty-seventh day of January, one thousand eight hundred and eighty-, the exclusive right to make, use, and vend the said invention throughout the United States and the Territories thereof.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington this ______ day of ______, in the year of our Lord one thousand eight hundred and ______, and of the Independence of the United States of America the one hundred and fourth.

A. Bell,
Acting Secretary of the Interior.

Countersigned:

H. E. Paine,
Commissioner of Patents.

(2401—3,000.)

8945

Defendant's Exhibit File Wrapper and Contents of Edison Patent No. 227,229.

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE.

To all Persons to whom these Patents shall come Greeting:

This is to certify, that the annexed is a true copy 8946
from the Files of this Office, of the File Wrapper and Contents, in the matter of the Letters Patent granted Thomas A. Edison, May 4th, 1880, Number 227,229, for Improvement in Electric Lights.

[SEAL] In testimony whereof, I, E. M. Marble Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed this 11th day of November, in the year of our Lord one thousand eight hundred 8947
and eighty, and of the Independence of the United States the one hundred and fifth.

E. M. MARBLE,
Commissioner.

To the Honorable Commissioner of Patents;

Your Petitioner Thomas A. Edison, of Menlo Park in the State of New Jersey, prays that Letters Patent may be granted to him for the invention of Improvement in Electric Lights, Case No. 176, set forth in the 8948
annexed specification.

And further prays that you will recognize Samuel W. Serrell of the City of New York, N. Y., as his attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the Patent, and to transact all business in the Patent Office connected therewith.

Thomas A. Edison.

Menlo Park, N. J.
April 12th, 1879.

8949

UNITED STATES OF AMERICA.

MENLO PARK,
Middlesex County,
New Jersey.

On this Twelfth day of April in the year one thousand eight hundred and seventy-nine before the subscriber, a Notary Public in and for said State, personally appeared the within named Thomas A. Edison, and made solemn oath that he verily believes himself
8950 to be the original and first inventor of the within described Improvement in Electric Lights and that he does not know and does not believe that the same was ever before known or used, and that he is a citizen of the United States, and a resident of Menlo Park New Jersey.

Thomas A. Edison.

Sworn to before me, the day and year above written

STOCKTON L. GRIFFIN.
Notary Public.

8951 { L. S. }

To all whom it may Concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the State of New Jersey, have invented an Improvement in Electric Lights, Case No. 176, of which the following is a specification.

When Platina and other metals that fuse at a high temperature are exposed to high heat and then cooled
8952 in the atmosphere, they are injured so that they are not well adapted to use in electric lights for along period of time.

I enclose the conductor that forms the electric candle in a transparent case, and heat the same gradually to expel any gases from the material of the candle. I form a vacuum in the transparent case, and then seal the same hermetically so that all injurious atmospheric influences are avoided.

8953

The invention further consists of a vacuum receptacle made entirely of glass and sealed by melting the same in combination with an incandescent continuous conductor pyro-insulated.

The invention further consists in winding pyro-insulated wire upon a bobbin of a compressed infusible substance such as lime.

The invention further consists in placing the vacuum bulb within another glass receptacle also closed
from the air, and employing the expansion of the air 8954
between the two receptacles due to the heat of the incandescent bobbin to produce a movement which shall disconnect the lamps from the electric circuit when its temperature is too great.

The drawing shows a section of the apparatus in which B is the transparent bulb. This bulb is open at the smaller end and the burner A inserted and the open end of the tube is placed in connection with a mercury vacuum pump, the platina wires *g* and *f*
passing through. 8955

The burner is connected with a battery and variable resistance coil while the vacuum is being made; The heat of the bobbin *d* is in the course of 1 hour brought gradually from the temperature of the air to vivid incandescence, when the vacuum is considered practically perfect, the open end of the tube is melted and sealed, the platina wires passing through the glass are also sealed.

Thus I am enabled to obtain a nearly perfect vacu-
um, which is permanent and at the same time gives the 8956
platinum wire a new and unknown property of great value in electric lighting which is, that a platina wire which melts in the open air at a point where it emits a light equal to four candles will, when operated upon as described emit a light equal to twenty-five candles without fusion. The reason why the melting point of the metal is thus raised is, that in the act of making the vacuum with the metal under heat all the gases

8957

which are contained in its pores are withdrawn, and when the receptacle is sealed, cannot re-enter when cold, hence unequal and sudden expansions cannot take place and the wire is never cracked; but if left uncovered, becomes as bright as the most polished silver, an appearance which cannot be given it in any other way.

On the other hand it is known that the metals of the platinum group have in a surprising degree the pecu-
8958 liar power of absorbing within their pores many volumes of gas and it is the sudden expansion of this gas upon a sudden accession of heat that disrupts the wires and produces cracks which extend nearly to its centre when the wire is brought to moderate incandescence in the open air.

These cracks set up a great resistance to the passage of the current and at these points become abnormally heated hence the platina wire easily melts, where-
8959 as no such cracks are noticed when the wire has been operated upon in the vacuum and all its gases pumped out. *e*, is a cylinder of lime with a small spool on its extermity on which the wire is coiled; about 30 feet of platinum or iridium wire, coated with magnesia oxide is coiled upon the spool.

The wire may be of any size but I prefer to use wire 005 of an inch in diameter which will give a resistance when incandescent of about 750 ohms. By the use of such high resistant lamps I am enabled to place a
8960 great number in multiple arc without bringing the total resistance of all the lamps to such a low point as to require a large main conductor but on the contrary I am enabled to use a main conductor of very moderate dimensions; another important point is gained by the use of lamps of high resistance as the resistance of the wires leading from the main conductors may be of very moderate dimensions hence can be placed in the pipes already used for gas and at the same time effect a great saving in the cost of wire.

8961

Still another point gained is that the high resistance of the lamps allows all to be placed in multiple arc which is the only method where the maximum economy is attainable as the lamps when connected to the circuit draw from the central station just sufficient current to maintain it at the proper temperature and, if by accident, or want of regularity in the main current the strength of the current should increase abnormally the excess of heat sets the thermal regulator in motion and disconnect the lamp entirely from the cir- 8962
cuit thus stopping all further consumption of energy until the temperature of the lamp is reduced to its normal conditions. I will state that these changes are not perceptible to the eye, hence the lamp cannot consume any more energy than that required to cause it to emit a certain light.

No loss in economy occurs by using so large a resistance because the loss of energy is proportionate to the radiating surface exposed to the air and its temperature and is independent of the resistance of the 8963
wire forming such surface. *m*, is a lime cup into which the small end of the vacuum burner is held, the platina wires pass under it to the binding posts *H K*. *n*, is the thermal regulator operated by the expansion of the air; when the temperature of the air between the bulbs becomes to great the diaphragm bulges outwards and the point *o*, separates the spring *p* from *R*, and disconnects the lamp from the circuit where it remains until the temperature is reduced to the normal condition.

The spark upon the point is very small as I employ 8964
constant field magnets at the central station hence the powerful sparks due to the secondary current set up by the weakening of the powerful field magnet is avoided.

I will mention that the second globe *c*, might be made entirely of glass and the aneroid diaphragm provided with a platina tube be sealed in the glass or the aneroid itself be made of glass.

1

Insert
"A"
Jan. 8, 1880.

8965 I claim as my invention

First. In combination with a sealed vacuum chamber made entirely of glass, a continuous incandescent metallic conductor as set forth.

Substitute "B" Jan. 8, 1880.

Second. The method herein described of preparing metallic conductors for electric candles consisting in freeing the metallic conductors of gases in a vacuum and afterwards sealing the same into an air-tight transparent case, substantially as specified.

8966 *Third.* In an electric lamp the combination with a sealed transparent vacuum case of a bobbin of pyro-insulated wire wound upon an infusible substance substantially as specified.

Fourth. The combination of a transparent vacuum case, of a continuous conductor forming an electric candle and a second transparent case forming a closed chamber for the purposes set forth.

Fifth. The use of a salt or any metal whose oxide is not readily fusible and which salt is decomposed by heat substantially as and for the purposes set forth.

8967 *Sixth.* The combination of the conductor *d*, forming an electric candle, the transparent sealed case *B*, the transparent case *c* enclosing the case *B*, and the thermostatic regulator *n*, *o*, *p*, *R*, substantially as set forth.

Signed by me this 12th, day of April A. D. 1879.

Witnesses
S. L. Griffin
Edwin M. Fox

THOMAS A. EDISON.

8968 [Endorsed: Dated April 12, 1879. Thos. A. Edison, Imp't in Electric Lights, case No 176, U. S. Patent Office, April 21, 1879]

DEPARTMENT OF THE INTERIOR. 8969

UNITED STATES PATENT OFFICE
WASHINGTON, D. C., MAY 22, 1879.

T. A. EDISON,
Care of L. W. SERRELL,
Box 4689, N. Y. City.,

Electric Lights, Filed April 21, '79, Case 176.

On examination claim 1 of this case is found to be substantially met by patent of Sawyer and Man 205,- 8970
144 of 1878, Electric Light, Claim 2 is met by patent of Sawyer and Man 211,262 Jan. 7, 1879, Electric Light, Claim 3 is met by Eng. pat. No. 2,410 of 1875, Since the pyro-insulated coil is shown in a prior case.

H. C. TOWNSEND,
Ex'r.

C. L. BUCKINGHAM,
Ass't.

[Endorsed: ?-1 Rejection May 22, 1879.]

NEW YORK, JANY. 7th, 1880. 8971

HON COMMISSIONER OF PATENTS.

SIR:

In the matter of my application for a Patent on Electric Lights case 176, filed April 21, 1879, I amend the specification by inserting before the claims as follows.

I am aware that an electric lamp has been made in which glass has been combined with other substances to form a case, and that efforts have been made to keep such case air-tight, but the changes of temperature have prevented the maintainance of a vacuum, or the exclusion of the atmophere. In my improve- 8972 "A"
ment the chamber containing the light is made entirely of glass, and I am able to obtain and maintain a vacuum, because there is no substance joined to the glass, hence the entire chamber can be hermetically sealed and the conductors of metal passing through the glass and around which the glass is melted, are so small as not to injure the glass by their expansion.

8973 I am also aware that carbon has been heated in the presence of both liquid and gaseous materials for changing its character and adapting it to an electric-light. In my present invention the gaseous materials contained in metallic wire, are driven off by the action of heat, evolved by an electric current while the wire is in a vacuum, so that the pores of the metal are not filled with any extraneous substance, but on the contrary the metal is solidified by the removal of extraneous matter and the pores closed.

8974 In my application No. 166, I have set forth an electric lamp formed of pyro-insulated metal. I do not therefore claim the same herein."

By erasing claims 1st, 2nd and 3rd, and inserting.

"B" " *First.* In an electric lamp, the combination with a hermetically sealed vacuum chamber made entirely of glass of metallic conductors passing through the glass and around which the glass is melted and an incandescent conductor placed in the electric circuit substantially as set forth.

Substitute "C" per Amd't Feb. 3, 1880.

8975 *Second.* The method herein specified of preparing metallic conductors for electric lamps, consisting in enclosing the conductor in a glass case, heating the same by an electric current exhausting the atmosphere from the glass case and then hermetically sealing such case, substantially as set forth.

Third. The combination in an electric lamp of a hermetically sealed vacuum case made entirely of glass, conducting wires passing through the glass, and around which the glass is melted, and an incandescent body

8976 formed of a pyro-insulated wire and an infusible coat for the same substantially as set forth.

Respectfully yours

THOS. A. EDISON,

per

LEMUEL W. SERRELL.

Atty.

[Endorsed: $\frac{2}{?}$ "A B" 2 Amendment, Jan. 8, 1880. U. S. Patent Office, Jan. 8, 1880, Thos. A. Edison. Electric Lights, Case 176. Amendment for Room 118.]

8977

DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE,
WASHINGTON D. C. JAN. 13, 1880.

T. A. EDISON,
Care of L. W. SERRELL,
P. O. Box 4689, N. Y. City,

Electric Lights, Filed Apr. 21, '79. Case 176.

Claims 1 and 3 as amended are fully met by Eng. pat of Fox 4626 of 1878. Claim 2 is substantially met by matter set forth in patent of Sawyer and Man 211,262 Jan. 7, 1879. Claims 1, 2 and 3 are rejected. 8978

H. C. TOWNSEND,
Exr.

C. L. Buckingham.
Asst.

[Endorsed: $\frac{2}{?}$ 3 Rejection Jan. 13, 1880.]

8979

TO THE COMM'R OF PATENTS.

In the matter of my app'n for Patent for Imp't in Electric Lights No. 176, filed April 21, 1879, I hereby appoint G. W. Dyer and Z. F. Wilber of the firm Dyer and Wilber Associate Attorneys, to prosecute said application, to make alterations and amendments therein to receive the patent, and to transact all business in the Patent Office connected therewith in my place and stead. Correspondence to be with them. 8980

Signed at Menlo Park, New Jersey, this 24th day of January 1880.

T. A. EDISON.

[Endorsed: $\frac{2}{?}$ 4 Asso. Power of Atty., Jan. 30, 1880. U. S. Patent Office, Jan. 30, 1880.]

8981

NEW YORK JAN. 24, 1880.

HON. COMM'R OF PATENTS.

SIR: In the matter of my application for a patent on Electric Light No. 176 filed April 21, 1877, the accompanying affidavit shows that the English patent 4,626 of 1878 has no bearing upon the present invention.

The patent of Sawyer and Man 211,262 does not consolidate metal by removing the gases and closing the pores; the filling up of pores in carbon by an ad-
8982 ditional material is radically different to the fusing or nearly so of platina while the air is exhausted in order that the platina may consolidate. The 2nd claim is removed and the following substituted.

Second. The method herein specified of treating metallic conductors for electric lamps consisting in enclosing the conductors in a glass case, heating the conductor by an electric current and then hermetically sealing such glass case, substantially as set forth."

"C"

8983 Line 8, para. 8 "enters" should read "omits"

THOS A. EDISON,
per LEMUEL W. SERRELL.

MENLO PARK in the }
State of New Jersey. }

Thomas A. Edison, being duly sworn deposes and says that the invention set forth in his application No. 176 for a patent on Electric Lights, filed April 21, 1879 was made by him before the patent granted in Great Britain No. 4,626 of 1878, or the publication thereof
8984 and at the time of making his application he believed, and still believes himself to be the first inventor of the improvement set forth in his said application.

T. A. EDISON.

Subscribed and sworn to this 29th day of Jan. 1880, before me

S. L. GRIFFIN.
[L. S.] Notary.

[Endorsed: $\frac{8}{7}$ "C" 5 Amendment, Feb. 3rd, 1880 4626 of 1878. U. S. Patent Office, Feb. 3, 1880. Thos. A. Edison, Electric Light.]

8985

HON COMMISSIONER OF PATENTS.

SIR: In the matter of my application No. 176, filed April 21, 1877. I desire to submit the case on the amendment and argument filed February 3rd, 1880, with these additional remarks.

1st. The reference English Patent 4,626 of 1878, is not good, because, while sealed Jan'y 24, 1879, the complete specification was not filed until May 14, 1879, over 3 weeks after the filing of the application 8986
under consideration. Until that complete specification was filed there was no patenting ("made open" see Brooks *vs* Norcross U. S. Supreme Courts) or publication sufficient to defeat my application.

2nd. The complete specification refers to a lamp of the Lodyguine type rather than to mine, the glass cover is to be filled "with some gas or vapor which has no action on the incandescent material."

3rd. While the Provisional specification speaks of sealing the case, the complete one does not. 8987

Sawyer and Man's patent is for a mode of manufacturing carbons by electrolysis and deposition, by so to speak, an electro-plating action a hydro-carbon being torn to pieces and the feed carbon deposited; I certainly do not claim this.

Respectfully submitted,
DYER AND WILBER.
Att'ys for Edison.

[Endorsed: $\frac{9}{7}$ 6. Letter to U. S. Patent Office, Feb. 18, 1880.]

8988

.989

Issue Division

All communications should be addressed to
"The Commissioner of Patents,
Washington, D. C."

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C. April 8, 1880,

Thomas A. Edison,
8990 Care Dyer and Wilber,
Present.

SIR: Your application for a patent for and Improvement in Electric Lights, filed Apr. "21,"1879, has been exAmined and allowed.

The final fee, Twenty Dollars, must be paid, and the Letters Patant bear date as of a date not later than six months from the time of this present notice of allowance.

8991 If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application, with additional fees, under the provisions of Section 4,897, Revised Statutes. The Office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fees at least Twenty Days prior to the conclusion of the six months allowed them by law. The printing, photolithographing, and engrossing of the
8992 several patent parts, preparatory to final signing and sealing, will consume the intervening time, and such work will not be done until after payment of the necessary fees.

8993

When you send the final fee you will also send, distinctly and plainly written, the name of the inventor and title of invention as above given, date of allowance (which is the date of this circular,) date of filing, and if assigned, the names of the assignees.

If you desire to have the patent issued to assignees, an assignment containing a request to that effect, together with the fee for recording the same, must be filed in this office on or before the date of payment of final fee.

Additional copies of specifications and Drawings 8994
will be charged for at the following rates: Single copies uncertified, 25 cents; twenty copies or more, 10 cents each. The money should accompany the order.

Very respectfully,
H. E. PAINE,
Commissioner of Patents.

8995

8996

8997

Memorandum.
of
Fee Paid at U. S. Patent Office.
Inventor.
Thomas A. Edison.
Patent to be issued to—

Name of Invention as allowed;
Electric Light.
8998 Date of Payment,
April 15, 1880.
Fee
$20,00
Solicitor
Dyer and Wilber
Date of Circular of Allowance.
April 8, 1880
8999 Send Patent to
Dyer and Wilber. City.
[Endorsed: U. S. Patent Office, April 15, 1880.]

9000

1879. 9001

Div. 16. (No. 176)
No. 227,229.

Of Thomas A. Edison.
Menlo Park.
County of
State of New Jersey.
Electric Lights.

Rec'd	April	21,	1879.
Petition	"	"	"
Affidavit	"	"	"
Specification	"	"	"
Drawing	"	"	"
Model	"	"	"

9002

Cert. dep.
Cash $15, April 21, 1879.
Add'l Fee Cert
" " Cash $20, April 15, 1880.
Examined April 6, 1880. H. C. Townsend.
Issue April 8, 1880. Arthur W. Crossley. 9003
Patented May 4, 1880.
Circular Apr. 8, 1880.

Dyer and Wilber, Asso.
Washington,
D. C.

Lemuel W. Serrell.
Box 4,689.
N. Y. City.

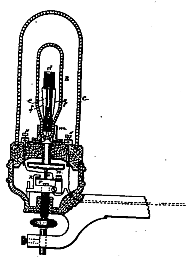
1879.
Contents:
Application papers
Rej. May 22, 1879.
Amdt. Jan. 8th, 1880. A. B.
Rej. Jan. 13, '80 9004
Asso. Power of Atty. Jan. 30. '80.
Amd't. Feb. 3rd, 1880. "C."
Letter to Office Feb. 18, '80.
Brief Apl. 6, 1880.

Title.
Improvement in Electric Lights.
36 Electricity
Electric Lights.
[Endorsed: T. A. Edison, File Wraper and Contents—
Electric Light, May 4th, 1880, No. 227,229.]

T. A. EDISON.
Electric-Lights.

No. 227,229. Patented May 4, 1880.

Case No. 176.



Witnesses
Chas H. Smith
Geo. T. Pinckney

Inventor
Thomas A. Edison.
for Lemuel W. Serrell att'y

Defendants Exhibit Edison Patent 227,229

UNITED STATES PATENT OFFICE.

JMH

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRIC LIGHT.

SPECIFICATION forming part of Letters Patent No. 227,229, dated May 4, 1880.

Application filed April 21, 1879.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the State of New Jersey, have invented an Improvement in Electric Lights, (Case No. 176,) of which the following is a specification.

When platina and other metals that fuse at a high temperature are exposed to high heat and then cooled in the atmosphere they are injured, so that they are not well adapted to use in electric lights for a long period of time.

I inclose the conductor that forms the electric candle in a transparent case and heat the same gradually to expel any gases from the material of the candle. I form a vacuum in the transparent case and then seal the same hermetically, so that all injurious atmospheric influences are avoided.

The invention further consists of a vacuum-receptacle made entirely of glass and sealed by melting the same in combination with an incandescent continuous conductor pyro-insulated.

The invention further consists in winding pyro-insulated wire upon a bottom of a compressed infusible substance, such as lime.

The invention further consists in placing the vacuum-bulb within another glass receptacle, also closed from the air, and employing the expansion of the air between the two receptacles due to the heat of the incandescent bobbin to produce a movement which shall disconnect the lamps from the electric circuit when its temperature is too great.

The drawing shows a section of the apparatus, in which B is the transparent bulb. This bulb is open at the smaller end and the burner *d* inserted, and the open end of the tube is placed in connection with a mercury vacuum-pump, the platina wires *g* and *f* passing through. The burner is connected with a battery and variable-resistance coil while the vacuum is being made. The heat of the bobbin *d* is, in the course of one hour, brought gradually from the temperature of the air to vivid incandescence. When the vacuum is considered practically perfect the open end of the tube is melted and sealed. The platina wires passing through the glass are also sealed.

Thus I am enabled to obtain a nearly-perfect vacuum, which is permanent, and at the same time give the platinum wire a new and unknown property of great value in electric lighting, which is, that a platina wire which melts in the open air at a point where it emits a light equal to four candles will, when operated upon as described, emit a light equal to twenty-five candles without fusion. The reason why the melting-point of the metal is thus raised is, that in the act of making the vacuum with the metal under heat all the gases which are contained in its pores are withdrawn, and when the receptacle is sealed cannot re-enter when cold; hence unequal and sudden expansions cannot take place and the wire is never cracked, but if left uncovered becomes as bright as the most polished silver—an appearance which cannot be given it in any other way. On the other hand, it is known that the metals of the platinum group have, in a surprising degree, the peculiar power of absorbing within their pores many volumes of gas, and it is the sudden expansion of this gas upon a sudden accession of heat that disrupts the wire and produces cracks, which extend nearly to its center when the wire is brought to moderate incandescence in the open air. These cracks set up a great resistance to the passage of the current, and at these points become abnormally heated; hence the platina wire easily melts, whereas no such cracks are noticed when the wire has been operated upon in the vacuum and all its gases pumped out.

c is a cylinder, of lime, with a small spool on its extremity, on which the wire is coiled. About thirty feet of platinum or iridium wire coated with magnesia oxide is coiled upon the spool.

The wire may be of any size; but I prefer to use wire .005 of an inch in diameter, which will give a resistance when incandescent of about seven hundred and fifty ohms. By the use of such high-resistant lamps I am enabled to place a great number in multiple arc without bringing the total resistance of all the lamps to such a low point as to require a large main conductor; but, on the contrary, I am enabled to use a main conductor of very moderate dimensions.

Another important point is gained by the use of lamps of high resistance, as the resistance of the wires leading from the main conductors may be of very moderate dimensions; hence can be placed in the pipes already used for

gas, and at the same time effect a great saving in the cost of wire.

Still another point gained is, that the high resistance of the lamps allows all to be placed in multiple arc, which is the only method where the maximum economy is attainable, as the lamps, when connected to the circuit, draw from the central station just sufficient current to maintain it at the proper temperature, and if by accident or want of regularity in the main current the strength of the current should increase abnormally, the excess of heat sets the thermal regulator in motion and disconnects the lamp entirely from the circuit, thus stopping all further consumption of energy until the temperature of the lamp is reduced to its normal conditions. I will state that these changes are not perceptible to the eye; hence the lamp cannot consume any more energy than that required to cause it to emit a certain light.

No loss in economy occurs by using so large a resistance, because the loss of energy is proportionate to the radiating-surface exposed to the air and its temperature, and is independent of the resistance of the wire forming such surface.

m is a lime cup, into which the small end of the vacuum-burner is held. The platina wires pass under it to the binding-posts H K.

n is the thermal regulator, operated by the expansion of the air. When the temperature of the air between the bulbs becomes too great, the diaphragm bulges outward and the point *o* separates the spring *p* from R and disconnects the lamp from the circuit, where it remains until the temperature is reduced to the normal condition.

The spark upon the point is very small, as I employ constant field-magnets at the central station; hence the powerful sparks due to the secondary current set up by the weakening of the powerful field-magnet is avoided.

I will mention that the second globe *c* might be made entirely of glass, and the aneroid-diaphragm, provided with a platina tube, be sealed in the glass, or the aneroid itself be made of glass.

I am aware that an electric lamp has been made in which glass has been combined with other substances to form a case, and that efforts have been made to keep such case air-tight; but the changes of temperature have prevented the maintenance of a vacuum or the exclusion of the atmosphere. In my improvement the chamber containing the light is made entirely of glass, and I am able to obtain and maintain a vacuum, because there is no substance joined to the glass; hence the entire chamber can be hermetically sealed and the conductors of metal passing through the glass and around which the glass is melted are so small as not to injure the glass by their expansion.

I am also aware that carbon has been heated in the presence of both liquid and gaseous materials for changing its character and adapting it to an electric light. In my present invention the gaseous materials contained in metallic wire are driven off by the action of heat evolved by an electric current while the wire is in a vacuum, so that the pores of the metal are not filled with any extraneous substance; but, on the contrary, the metal is solidified by the removal of extraneous matter and the pores closed.

In my application No. 166 I have set forth an electric lamp formed of pyro-insulated metal. I do not, therefore, claim the same herein.

I claim as my invention—

1. In an electric lamp, the combination, with a hermetically-sealed vacuum-chamber made entirely of glass, of metallic conductors passing through the glass and around which the glass is melted, and an incandescent conductor placed in the electric circuit, substantially as set forth.

2. The method herein specified of treating metallic conductors for electric lamps, consisting in inclosing the conductor in a glass case, exhausting the atmosphere from such case, heating the conductor by an electric current, and then hermetically sealing such glass case, substantially as set forth.

3. The combination, in an electric lamp, of a hermetically-sealed vacuum-case made entirely of glass, conducting-wires passing through the glass and around which the glass is melted, and an incandescent body formed of a pyro-insulated wire and an infusible core for the same, substantially as set forth.

4. The combination of a transparent vacuum-case, a continuous conductor forming an electric candle, and a second transparent case forming a closed chamber, for the purpose set forth.

5. The combination of the conductor *d*, forming an electric candle, the transparent sealed case B, the transparent case *c*, inclosing the case B, and the thermostatic regulator *n o p* R, substantially as set forth.

Signed by me this 12th day of April, A. D. 1879.

THOMAS A. EDISON.

Witnesses:

S. L. GRIFFIN,

EDWIN M. FOX.

9021

Defendant's Exhibit File Wrapper and Contents Edison's paper-carbon Application.

S. M. H., Exr.

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

9022 *To all Persons to whom these Presents shall come, Greeting.*

This is to certify that the annexed is a true copy from the Files of this Office, of the File Wrapper and Contents in the matter of the Application of Thomas A. Edison, Filed December 11, 1879, Serial Number 14,630, for Improvement in Electric Lamps, and Method of Making the same.

9023 In testimony whereof I, Benton J. Hall, Commissioner of Patents, have caused the Seal of the Patent Office to be affixed this 28th day of March, in the year of our Lord, one thousand eight hundred and eighty-nine, and of the Independence of the United States the one hundred and thirteenth.

[SEAL.]

Benton J. Hall,

9024 Commissioner.

To the Hon. Commissioner of Patents: 9025

Your Petitioner, Thomas A. Edison, of Menlo Park, in the State of New Jersey, prays that Letters Patent may be granted to him for the invention of an Improvement in Electric Lamps and in the method of manufacturing the same set forth in the annexed specification. (Case No. 187)

And further prays that you will recognize Lemuel W. Serrell, of the City of New York, N.Y., as his attorney, with full power of substitution and revocation, to, 9026
prosecute this appplication to make alterations and amendments therein to receive the Patent and to transact all business in the Patent Office connected therewith.

Thomas A. Edison.

Menlo Park, Dec. 8th, 1879.

United States of America, }
State of N. J. } 9027
County of Middlesex. }

On this eighth day of Dec., in the year one thousand eighth hundred and seventy-nine before the subscriber, a Notary Public, in and for said State, personally appeared the within-named Thomas A. Edison, and made solemn oath that he verily believes himself to be the original and first inventor of the within-described imp't. in Electric Lamps, and in the method of manufacturing the same, and that he does not know and does not believe that the same was ever 9028
before known or used, and that he is a citizen of the United States, and a resident of Menlo Park, N. J.

Thomas A. Edison.

Sworn to before me, the day and year above written.

S. L. Griffin,

[L. S.] Notary Public.

9029 To all whom it may concern: Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, Electrician, have invented an Improvement in Electric Lamps and in the method of manufacturing the same, of which the following is a specification. In a former application made by me for Letters Patent in the United States (case 186) an improvement in electric
Feb. 17, 1880. lamps is set forth wherein a filament of carbon is enclosed in a glass bulb and the atmosphere removed as
9030 nearly as possible, and the carbon is brought to incandescence by an electric current to form the lamp.

My present invention relates to an improvement in
Dec. 15, Feb. 17, 1880. the process of manufacturing the carbon ~~filament and in the means for securing the same to the conductors.~~ Λ
Insert "B" per Amd't 4, Feb. 17, 1880.

I make use of paper of the desired thickness as free as possible from foreign substances or adulterations and for this purpose I prefer and use "bristol-board". With suitable instruments, such as a punch and die, I, cut out a narrow strip of this paper, preferably in the
9031 form of an elliptical bow or an arc of a circle, the ends of the strip being by preference wider than the other portions.

A number of these pieces of paper are laid flatwise in the bottom of a mold, preferably of wrought iron, and there is laid on them a light weight in the form of a flat piece of gas retort carbon or other device that will not be distorted by the heat. If several of these are laid one on the other in the mold, a piece of
9032 tissue paper is interposed between each one and the next.

A cover is used to close the mold and the mold is raised very gradually to a temperature of about six hundred degrees Fahr. This allows the volatile portions of the paper to pass away and at the same time the mold retains the paper in its proper shape and the

paper is prevented from curling up and becoming distorted as it would be likely to do if the heat were applied suddenly, or the light weight dispensed with. 9033

The mold is now placed in a furnace and heated almost to a white heat and then removed and allowed to cool gradually.

The carbon filaments will be found to be smaller than the cardboard blanks and to be sufficiently strong and flexible for handling. The ends of the carbon are to be secured to the metallic conductors in 9034
any convenient manner.

The carbon filaments prepared as aforesaid are very uniform in their resistance to the electric current, and I make them thin and of a sufficient length to offer a great resistance to the passage of the current.

The clamps that connect the conductors to the ends do not require to be pressed with much force on the carbon, because the resistance to the passage of he current between the clamps and the carbon will be less than the resistance of the carbon filament, hence 9035
but little heat will be developed at the clamps.

In ordinary electric lamps the large carbons do not offer much resistance to the electric current and unless the clamps are very firmly pressed upon the carbon, the current meets with considerable resistance at the clamps, and hence heat is developed at such clamps.

The clamps that I prefer are made of a steel spring tipped at the ends with platina or similar metal; the spring is bent into a circle or bow and the ends crossed and turned back towards each other similar in shape 9036 Substitute "B" per Amd't Dec. 15, 1880.
to the figure 8 with the opening for the carbon between the spring ends at the upper part: the object of this shape is that the pressure of the clamps on the carbon may be increased by the expansion of the spring by the heat of the lamp, instead of being lessened as it would be if the wire, was only bent into a single bow.

9037 The spring clamps are connected to the platina or similar conducting wires by dips, and the platina wires pass through the glass of the globe or bulb that contains the lamp: the air is to be exhausted from the bulb by any suitable means and it is preferable to exhaust said air as perfectly as possible, say to the one eight hundred thousandth of an atmosphere.

The lamps are suspended or supported in any convenient manner, and the electric current from a magneto electric machine, or other source of electricity is
9038 passed through the lamp and brings the carbon filament to a high incandescence and the lamp is very durable and a large number of such lamps can be placed in the electric circuit in multiple arc, or otherwise as desired.

In the drawing

Fig. 1, is a vertical section of the lamp complete.

Fig. 2, is a side view in larger size of the clamping device.

Fig. 3, is a section at the line x, x, in still larger
9039 size.

Fig. 4, is the wire forming one of the clamps before it is bent up to shape.

Fig. 5, is the paper blank before it is carbonized, and

Fig. 6, is a section of the box.

The blank *a*, is cut out of paper material such as "bristol-board", in the proper shape; the form shown in Fig. 5, is preferred; the same is laid in the metal mold *b* and when several are laid one on the other,
9040 pieces of thin paper are introduced between. The weight *d*, is laid on these; it is to be heavy enough to prevent the paper curling up under the action of the heat, but it allows the paper to contract as the volatile matters are expelled by the heat. This weight *d*, is of gas retort carbon. The cover *e*, is placed on the mold and secured, and the mold is heated as before described.

The carbon filament *i*, forms the lamp when rendered 9041
incandescent by the electric current passed through it.

The clamp is made of the wire *h*, at the ends of which are tips or small rivets *r*, of platina or similar material.

The wire is bent up and crossed as shown so as to act as a spring in clamping the end of the carbon filament that is placed within such clamp. "The wire ~~is attached to~~ a small stock *o*, into which the conducting
wire *t*, passes and is clamped. The conductors for the 9042
two ends of the carbon are inserted into the glass and the latter intimately melted around them, the carbon and clamps are connected to the wires and the parts introduced within the neck of the bulb *m*, and the glass melted at *v*, the air is exhausted from the globe by the tube *k*, which originally is ~~that passes away~~ as shown by dotted lines, ~~and the tube~~ melted together while the vacuum is maintained.

The lamp is ready for the conductors to be attached
to it and the carbon is rendered incandescent by the 9043
current that passes through the same. It is durable as there is nothing to combine with the carbon and it is substantially indestructible.

I claim as my invention

First. The manufacture of carbons for electric lights from paper.

Second. The method herein specified of manufac-
turing carbons for electric lights consisting in expos- 9044
ing the filaments of paper to the action of heat in a mold to drive off the volatile portions and carbonize the paper, substantially as set forth.

Dec. 15, 1880.

Dec. 15, 1880.
Insert "C"
per Amd't
Dec. 15, 1880.

Insert "D"
per Amd't
Dec. 15, 1880.
Substitute
"A"
per Amd't
Jan. 3, 1880.
Insert "E"
March 11, 1882.

9045 *Third.* A carbon for electric lights made as a filament with the ends broader for the clamping devices that connect the conductors.

Erased per Amd't Dec. 15, 1880.

Fourth. The clamp for the carbon of an electric lamp composed of a bow or elliptical spring with the ends crossing each other and receiving between them the carbon substantially as set forth.

9046 Signed by me this 8th day of December, A. D., 1879.

THOMAS A. EDISON.

Witnesses:

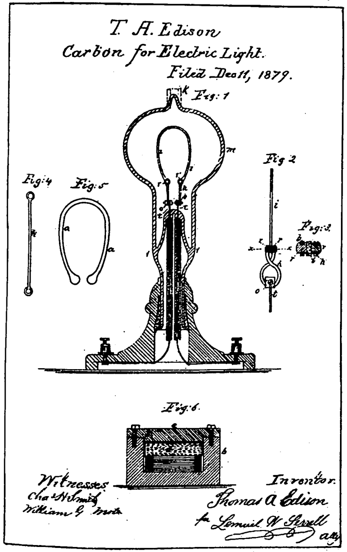
S. L. GRIFFIN,

J. F. DOWNING.

[Endorsed: 1/2 Case No. 187; dated Dec 8, 1879; Thos. A. Edison; Impt. in Electric Lamps, and in the method of manufacturing the same; U. S. Patent Office, Dec. 11, 1879.]

9047

9048



9057

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., Dec. 30, 1879.

Case 187.

T. A. EDISON,

Care L. W. SERRELL, 9058

Box 4,689, N. Y. City.

Electric lamps and methods of making the same, Filed Dec. 11, '79.

Claim 1 is ambiguous, it not being clear whether the claim covers an article or a process. Claim 3 is too broad. The word filament does not distinguish applicant's carbon from others except in degree.

C. L. BUCKINGHAM, 9059
Ass't.

H. C. TOWNSEND,
Ex'r.

[Endorsed: 166/30; 1; Rejection, Dec. 30, 1879.]

9060

9061

NEW YORK, January 2, 1880.

HON. COMR. OF PATENTS:

Sir—In the matter of my application, No. 187, for patent on electric lamps, filed Dec. 11, 1879 I amend the specification by inserting after title

"(Case No. 187)."

The *first* claim is erased and the following substituted:

Substitute "C" per Am'd't. Feb. 17

9062 ~~"*First.* An electric lamp formed of carbonized paper."~~

The third claim is believed to be correct, no other meaning than "thread like" is known to attach to the word "filament," and this claim is meant to apply to a thread like carbon *with* broad ends, and that is believed to be new.

Respectfully yours,

THOMAS A. EDISON.

per

LEMUEL W. SERRELL.

Atty.

9063 [Endorsed: 146/30 "A" 2 Amendment Jan. 3, 1880, cancelled. Thos. A. Edison; Electric Light; case 187 Amendment: U. S. Patent Office, Jan. 3, 1880.]

To the COMM'R of PATENTS,

In the matter of my app'n for Patent for Imp't in Electric Lights No. 187 filed December 11th, 1879, I hereby appoint G. W. Dyer and Z. F. Wilber of the firm Dyer & Wilber Associate Attorneys

9064 to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent Office connected therewith in my place and stead.

Correspondence to be with them

Signed at Menlo Park, New Jersey, this 24th day of January, 1880.

T. A. EDISON.

[Endorsed: 146/30; 3; Asso. power of Atty.; Jan. 30; U. S. Patent Office, Jan. 30, 1880.]

9065

HON. COMMISSIONER OF PATENTS,

SIR:—In the matter of my application, No. 187 for a patent for "Electric Light" filed Dec. 11th, 1879

I amend as follows:

Cancel amendment of January 3d, 1880.

Erase words "filament of" in 11th line, 1st page.

Erase "filament" line 18, page 1.

Insert after line 19, page 1,—

"I have found, that it is desirable in an electric lamp that there should be a very great resistance in a very small amount of incandescing material, and that carbon prepared from paper by my process possesses the necessary high resistance. 9066 "B"

By using such carbon, I am enabled to use an exceedingly small carbon so small that its dimensions are best expressed by applying to it the term filament it being thread like in size."

Erase first claim and insert—

First. The incandescent conductor, for an electric lamp formed of carbonized paper, substantially as set forth." 9067 "C"

It is believed these amendments obviate the office objections.

DYER & WILBER,

Attys. for Edison.

February 17th, '80.

[Endorsed: 146/30 4 "B. C." Amendment Feb. 17, 1880. Edison 187; Room 118; U. S. Patent Office, Feb. 17, 1880.] 9068

9069

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., Sep. 23, 1880.

T. A. EDISON,
Care DYER & WILBER,
Present.

U. S. Patent Office,
Ex'r. of Interferences,
Sep. 25, 1880.

Please find below a copy of a communication from the Examiner concerning your applic. filed Dec. 11, 1879, for Electric Lamps, etc.,Case No. 187.

9070 Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Room No. 152
All communications should be addressed to
"The Commissioner of Patents,
Washington, D. C."

Your case, above referred to, is adjudged to interfere with others, hereafter specified, and the question
9071 of priority will be determined in conformity with the Rules.

The statement demanded by Rule 105 must be sealed up and filed on or before the 25th day of Oct., 1880, with the subject of the invention, and name of party filing it, indorsed on the envelope. The subject-matter involved in the interference is,

The incandescent conductor for an electric lamp formed of carbonized paper.

Edison's 1st claim, Sawyer & Man's 4th claim.

9072 The other parties to this interference are Sawyer & Man, whose application was filed Jan. 9,1880, No. 517
Wm. E. Sawyer, New York City.
Albon Man, Brooklyn, N. Y.
Care Baldwin, Hopkins & Peyton,
Asso. Attys,
Washington, D. C.

P. W. PAGE,
Asst. Ex'r.

H. C. TOWNSEND,
Examiner.

[Endorsed: $\frac{146}{25}$; 5; Int. $\frac{13}{8}$; Sept. 23, '80.]

9073

Room 152. (Edison Number 187.)

T. A. EDISON, Electric Lamps, filed Dec. 11th 1879.

HON. COMMISSIONER OF PATENTS:

This application is now in interference with an application filed by Sawyer and Man, as to the part of the subject matter contained therein only, there being claims and subject matter not interferring with the 9074
claims made by Sawyer and Man, or with any claims which could be made upon the subject matter shown or described by them.

The application can be legitimately divided.

I have therefore determined to take advantage of the provisions of rule 125, cancel by amendment the matter herein adjudged not to interfere, and to file a new application therefor, which application is this day filed and bears my serial number 264, and which is, as to such matter, a continuation of this application relating 9075
back thereto.

The present application is accordingly amended as follows:

Erase the words "and in the means for securing the same to the conductors," lines 18 and 19, page 1.

Erase from line 5, page 4, to line 13, page 5 inclusive and insert in lieu thereof:

"In order that not only the improvement in the carbon may be understood, but that the manner of the embodiment in a complete lamp, and its utility may "B"
be better understood, a complete lamp and the method 9076
of its manufacture will be illustrated and described."

In lines 25 and 26, page 6 erase "is attached to" and insert "passes through."

In line 10, page 7 erase "that passes away" and insert "which originally is."

In line 11, page 7 erase "and the tube" and insert

9077

"but which is."

"C" At end of line 11 insert "when a proper vacuum has been attained."

"D" Before claims insert:

Erased June 29, 1885. "It is not intended to claim anything herein shown and described except the incandescing conductor made of paper, as all such other matters of invention as are herein shown or described are only shown as incidental to, and illustrative of the manner of manufacture and use of the paper carbon, and from the subject mat-
9078 ter of another and separate application for a patent made by me."

Erase all claims except the first.

T. A. Edison,

per Dyer and Wilber,

His Attorneys.

Washington, D. C., December 15, 1880.

9079 [Endorsed: 16/30 No. 187. 6 Amendment, Dec. 15, 1880. "B D" U. S. Patent Office, Dec. 15, 1880.]

9080

 9081

New York, Feb'y., 18th 1882.

In Re-Interference
Sawyer and Man
vs.
Edison.

On appeal to,
Ex'r's in Chief.

"Incandescent Paper Carbons."

Hon. Comm'r Patents:

Sir: In the above entitled cause please recognize 9082
the Hon. Roscoe Conkling as an associate in the Case.
He will take charge of the argument on appeal.

Very Resp'y. &c.,

Z. F. Wilber.

[Endorsed: Asso. Atty. to Hon. Roscoe Conkling, Feb'y 18, 1882.]

In Re-Edison, Case 187.

T. A. Edison,

Electric Lamps. Filed Decr. 11, 1879. 9083

Hon. Com'r Patents,

Sir: This app'n is in interference a subject matter set forth in one claim out of four in a pending app'n of Sawyer and Man.

The remaining 3 claims in the Sawyer and Man app'n stand rejected.

In the declaration of the Interferences in the letter to Sawyer and Man, the Office stated "In declaring "this interference the objections standing against "Sawyer and Man's 1, 2 and 3 claims are not re- 9084
"moved."

In view however of the very peculiar rules now prevailing in the Office as to declaring interferences and as to when applications interfere, there is great risk, should the Examiner change the decision in such claims or he be overruled by any of the appellate tribunals, that such claims might be issued without notice to me and in derogation of my rights under the

9085 law. I therefore amend by adding such claims to my application in order that nothing possible to be done by me in the matter, be left undone.

Formal action thereon however will not be expected until the termination of the present interference proceedings.

Insert the numeral 1 before present claim in case and add claims

"2. An incandescing arc for an electric lamp of car-
9086 bonized fibrous or textile material, and of an arch or horseshoe shape, substantially as set forth.

"E" Substitute "F" June 20, 1882

3. This combination of an incandescing arc of carbon for an electric lamp of an arch or horseshoe shape, and a transparent hermetically-sealed chamber, from which oxygen or other gases capable of combining with carbon at a high temperature are excluded.

4. The combination of an incandescing arc of carbon for an electric lamp of an arch or horseshoe shape
9087 included in and forming part of an electric circuit, an a transparent hermetically-sealed chamber, from which oxygen and other gases capable of combining with carbon at a high temperature are excluded."

T. A. Edison,

per Z. F. Wilber.

His Atty.

March 10th, 1882.

[Endorsed: No. 16/35 Paper No. 9. Amend't. E Filed
9088 Mar. 11, 1882. Sawyer and Man; Motion denied; 1—28, '82; U. S. Patent Office, Mar. 11, 1882.]

9089

Edison's case, No. 187.

(Interference—Sawyer & Man)
vs.
Edison.

Serial No.
Filed, Dec. 11, 1879.
Improvement in Electric Lamps.

To the Commissioner of Patents:

In the above-named application, I hereby revoke the power of attorney given by me to Lemuel W. Ser- 9090
rell, Z. F. Wilber, or to Dyer & Wilber, and appoint instead as my attorney, Richard N. Dyer, of Menlo Park, New Jersey, with full power of substitution and revocation, to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent Office connected therewith.

Signed at Menlo Park, N. J., Aug. 8, 1882.

Thos. A. Edison. 9091

The undersigned, The Edison Electric Light Company, assignee of the invention set forth in the above application, hereby concurs and joins in the foregoing power of attorney.

Signed at New York City, August 10th, 1882.

The Edison Electric Light Company,
By S. B. Eaton,
Vice-President.

[Endorsed: Power of Attorney and Revocation; U. 9092
S. Patent Office, Aug. 14, 1882.]

9093

APPLICATION OF THOMAS A. EDISON.

Improvement in Electric Lights, filed Dec. 11, 1879, Serial No. . Edison's No. 187.

STATE OF NEW YORK, }
County of New York. } ss.:

THOMAS A. EDISON, being duly sworn, deposes and says that the Improvement set forth in the above en-
9094 titled application for patent was not, to his knowledge, in public use or on sale in the United States more than two years prior to said application.

THOS. A. EDISON.

Sworn to and subscribed before me, }
this 7th day of Oct., A. D., 1882. }

WM. H. MEADOWCROFT,

[L. S.] Notary Public,

9095 New York County.

[Endorsed: Dec. 11, 1879; C. 187; U. S. Patent Office, Oct. 11, 1882; Intf.]

9096

9097

Room 91. C.

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE, }
WASHINGTON, D. C., Feb. 19, 1885. }

THOMAS A. EDISON,
Care RICHARD N. DYER,
65 5th Ave., New York City.

"Application Electric Lamps and Method of Making the same." Filed Dec. 11, 1879.

Book No. $\frac{146}{30}$ 9098

The interference with Sawyer and Man having been decided against applicant, this case has been reconsidered with reference to the amendment filed Mar. 11, 1882.

Reference is made in the specification to another application, which is referred to as "(case 186)"; the number thus given fails to identify the case referred to, and if the reference is retained, the date of filing should be given. 9099

It is also found that by amendment filed Dec. 15, 1880, applicant limits the scope of this application to an "incandescing conductor made of paper;" the claims presented by amendment of March 11, 1882, which cover matter different from an incandescing conductor made of paper are therefore, not properly in this case.

Besides this, the first claim which is commensurate with the issue of the late interference cannot be al-
lowed to applicant, since the interference has been de- 9100
cided in favor of Sawyer and Man; the second claim which is broader than the interference issue, cannot be considered in this case for this reason alone. A defeated party cannot put under contribution the party which has been proved to be the prior inventor.

Claims 3 and 4 are anticipated by English Patent No. 3809, of 1872, Fig. 8.

The application is rejected.

C. J. KINTNER, Ex'r.

JOS. LYONS, 1st Ass't.

[Endorsed: No. $\frac{146}{30}$; paper No. 10; Rej.; dated Feb. 19, 1885.]

9101

THOMAS A. EDISON.

Electric Lamps. Filed December 11, 1879. Edison No. 187.

TO THE COMMISSIONER OF PATENTS:

SIR: In the above case I submit the following,—

Erase the disclaimer inserted before the claims and designated amendment "D."

Erase 2d, 3d, and 4th claims inserted by amendment dated March 10, 1882, and insert instead thereof the following,—

9102 *Second:* An incandescing conductor for an electric lamp, of carbonized fibrous or textile material and of an arch or horse shoe shape, substantially as hereinbefore set forth.

Third: The combination substantially as hereinbefore set forth, of an electric circuit and an incandescing conductor of carbonized fibrous material, included and forming part of said circuit, and a transparent hermetically sealed chamber in which the conductor is inclosed.

"F" 9103 *Fourth:* An incandescing electric lamp consisting of the following elements in combination; first, an illuminating-chamber made wholly of glass hermetically sealed, and out of which all carbon-consuming gas has been exhausted or driven; second, an electric circuit conductor passing through the glass wall of said chamber and hermetically sealed therein, as described; third, an illuminating conductor in said circuit, and forming part thereof within said chamber, consisting

9104 of carbon made from a fibrous or textile material, having the form of an arch or loop, substantially as described, for the purpose specified.

In the issue of patent No. 317,676, based on an application of Sawyer and Man, after an interference with this application, the office evidently overlooked the fact that the issue in that interference was upon the use specifically of carbonized paper as the incandescent conductor of an electric lamp, and, proceeding

9105

upon the illogical reasoning that the less includes the greater, granted a patent for the use of fibrous material without an interference with this application. To prevent just such an occurrence, applicant during the pendency of the interference inserted a claim to fibrous material and demanded an interference with the application of Sawyer and Man whenever the office should decide that the claim was patentable, Sawyer and Man's claim at the time standing rejected.

This amendment and demand is the paper dated March 10th 1882 and filed March 11, 1882. 9106

The present amendment is made so that the claim will conform precisely to the claims of Sawyer and Man, as since amended, and an interference is now demanded with the first, second and fourth claims of their patent No. 317, 676.

The claim on carbonized paper is retained, since it is proposed to commence proceedings to obtain a patent on this claim by Bill in Equity under section 4915 R. S. Respectfully, 9107

RICH'D N. DYER,
Atty for Edison.

9109

June 19, 1885.

STATE OF NEW YORK, }
County of New York. } ss.:

Thomas A. Edison, whose application for letters patent for an improvement in Electric Lamps was filed in the United States Patent Office on the 11th day of December, 1879, being duly sworn, deposes and says that he verily believes himself to be the original and first inventor of the improvement as described and
9110 claimed in the foregoing amendment, in addition to that which was embraced in the claims originally made, and that he does not know and does not believe that the same was ever known or used before his invention thereof and that the matter sought to be inserted formed a part of his original invention at the date of filing said application.

THOS. A. EDISON.

Sworn to and subscribed before }
me this 19th day of June, 1885. }

9111

JOHN C. TOMLINSON,
(L.S.) Notary Public,
N. Y. Co.

[Endorsed: No. 1⁄3 Paper No. 11. Amd't F Filed June 20, 1885. U. S. Patent Office; Jun. 20, 1885; Division XVI.]

9112

9113

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE, }
WASHINGTON, D. C., June 27, 1885. }
(Mailed June 30, 1885.)

THOS. A. EDISON,
Care R. N. DYER,
New York City.

Improvement in
Electric Lamps,
No. 1⁄3 Filed Dec. 11, 1879.

9114

The amendment filed 20th, inst., in the matter of the above named app'n has been considered.

In view of the limited statement of invention found in the application as originally filed, the claims then submitted and particularly in view of the specific terms of the disclaimer filed Dec. 15, 1880, it is believed that the last official action of Feb. 19, was correct and that applicant cannot now be allowed to broaden the scope of his alleged invention by putting up a new state of facts. It appears that applicant has specifi- 9115
cally disclaimed all matter in this application except the paper filament and upon this state of facts entered into and passed through an interference proceeding in which contest he failed to succeed. He has also signified his intention, in the last amendment, of proceeding by a bill in equity to have the Commissioner's decision reversed.

The examiner is firmly of the opinion that he should proceed in this direct course and not be now permitted to set aside as for naught that which he, the applicant, has in a clear and well defined manner delineated as 9116
his invention.

If this course of proceedings were admissible there would be no end to litigation.

9117

By his own actions must an applicant's case stand or fall and when he distinctly rules out a line of action designed to govern his application by that line of action must he be held?

Applicant will be required to reinstate his disclaimer and to erase all matter not in strict accord therewith, in order that he may proceed by bill in equity as indicated.

From this action refusing to admit the claims now
9118 submitted and requiring applicant to reinstate the disclaimer noted an appeal may be taken at once if desired to the Comm'r in person.

Further action pending such appeal is suspended.

C. J. Kintner,
Exr.

[Endorsed: Serial No. 146/30; paper No. 12; Rej.; dated June 27, 1885.]

9119

9120

Thomas A. Edison, 9121

Electric Lights,

Filed December 11, 1879.

To the Honorable Commissioner of Patents:

Sir: In the above entitled case, appeal is hereby taken to the Honorable Commissioner in person from the decision of the Principal Examiner, refusing to grant applicant's request for an interference with patent of Sawyer and Man No. 317,676 granted May 12th, 9122
1885.

For reasons of appeal it is submitted that the Examiner erred:

(1). In deciding that his action of February 19th, 1885 was correct.

(2). In deciding that the amendatory paper filed March 11, 1882, did not entitle Edison to an interference with Sawyer and Man's application while pending.

(3). In deciding that Edison is not now entitled to 9123
an interference with their patent.

An oral hearing is asked.

Respectfully,
Richard N. Dyer,
Atty. for Edison.

July 8, 1885.

[Endorsed: Filed Dec. 11, '79. Paper No. 13, Interlocutory Appeal filed July 11th, 1885. Mr. Emory; 9124
Room 4; the request for a declaration of an interference with the patent of Sawyer and Man is denied for the reasons stated by the examiner; Benton J. Hall, Commissioner; Feb. 24, 1888; 91; U. S. Patent Office, July 11, 1885.]

9125

Room No. 4.
All Communications should be addressed to
"The Commissioner of Patents
Washington, D. C."

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

9126 Duplicate. WASHINGTON, D. C., July 14th, 1885.

In the matter of the
Application of
THOMAS A. EDISON,
"Electric Lights,"
9127 Filed Dec. 11, '79.

Interlocutory Appeal.

SIR: You are hereby informed that a hearing on the above appeal from the decision of the Primary Examiner is fixed for Friday July 31st., 1885, at 1 P. M.

By direction of the Commissioner:

Very respectfully,
SCHUYLER DURYEE,
Chief Clerk.

9128 THOS. A. EDISON,
Care RICHD. N. DYER,
65 5th Ave., N. Y.

[Endorsed: Serial No. ; paper No. 14; notice of hearing; dated July 14, 1885.]

9129

IN THE U. S. PATENT OFFICE.

In re T. A. Edison, Electric Lights, filed Dec. 11, 1879.

Appeal to the Commissioner of Patents.

EXAMINER'S STATEMENT.

This appeal is taken from the examiner's decision refusing to declare an interference between certain claims specified, and similar claims found in patent to 9130
Sawyer and Man, 317,676, granted May 12, 1885.

The examiner's refusal was based upon three reasons, as follows:

1. This application was involved in an interference with the application upon which Sawyer and Man's patent was granted, and decided adversely to applicant.

2. This application was specifically limited to the issue of said interference, by a disclaimer to all other subject matter, filed Dec. 15, 1880, and hence applicant 9131
cannot now seek to avoid such disclaimer by reinstating matter so disclaimed.

3. A suit has been instituted by bill in Equity, on the part of Sawyer and Man, on the patent indicated, against this applicant and upon the identical claims applicant is now seeking to inject into this application.

With reference to the first point made by the examiner, it should be stated that the issue of the interference was as follows:

"An incandescent conductor for an electric lamp 9132
formed of carbonized paper."

This was to a species of filament of carbonized paper, which is acknowledged to be vegetable fiore. On the conclusion of the interference, Sawyer and Man having established their right to this species of vegetable filament, came before the examiner with broad claims to the genus, or to a carbonized filament of vegetable fibre and were permitted to take such claims.

9133

The Examiner has not examined the testimony set up by applicant and hence cannot pass upon this point, indeed, he is not called upon to do so. It is to be presumed that applicant made the stongest case he could, and that if Sawyer and Man were the first inventors of the species, they were also of the genus.

Concerning the second objection, the Examiner simply calls attention to the disclaimer which is as follows:

9134 "It is not intended to claim anything herein shown "and described except the incandescing conductor "made of paper, as all such other matters of invention as are herein shown or described are only shown "as incidental to, and illustrative of the manner of "manufacture and use of the paper carbon, and form "the subject matter of another and separate application of a patent made by me."

The Examiner is at a loss to know how anyone can can misinterpret this language.

9135 Now, after a period of over four years, it is sought to nullify this act, and to claim every feature shown and described.

It is respectfully submitted that an applicant should be held to his statements made deliberately and with an undoubted intent.

The third objection was not urged in the official action, but applicant was advised, verbally, that such an objection was entirely pertinent.

The examiner is advised, and has in his possession
9136 a copy of the bill in equity, filed by the Consolidated Electric Light Co., against the applicant, said bill being based upon the patent of Sawyer and Man, above referred to. The question then arises, should this office be put to the expense of instituting a proceeding which will be tried elsewhere, and should parties be put to a duplicated expense for determining a single issue.

9137

In this connection, attention is called to Commissioner Marble's decision in Frazier vs. Nicodemus and Weeks, Commissioner's MS. Dec. Vol. 23, p. 161, wherein he says:

"The motion to suspend proceedings in this case "until the Court is decided, which in substance in"volves the same issue, I think should be granted. It "is unnecessary that parties should be put to the ex"pense of taking their testimony twice to determine "which is the prior inventor, and, inasmuch as that 9138 "question will necessarily be determined by the "Court, this case should be suspended to await such "determination."

This, it will be observed was with relation to an interference already declared. It is thought that the rule should be more strongly observed, concerning cases where there is no actual contest in progress.

In view of these reasons the examiner begs to submit that his course of action was entirely correct.

Respectfully submitted, 9139

C. J. Kintner,

Examiner Division XVI.

July 30, 1885.

[Endorsed: Serial No. 136-30; paper No. 15; Ex'r's statement; dated July 30, 1885.]

9140

9141

No.

THOS. A. EDISON.

Electric Lights filed Decr. 11, 1879.

TO THE HON. COMR OF PATENTS :

In the above cause set for hearing on July 31, 1885, an Interlocutory Appeal to your Honor, I respectfully ask for a postponement of the hearing for one month, on account of the inability of Mr. R. N. Dyer, the
9142 regular Attorney, to attend to the same, by reason of the serious illness of his wife.

GEO. W. DYER,
Counsel for Edison.

[Endorsed: Serial No. 1413, 30. Paper, No. 16. Req. for postponement Filed July 30, 1885. U. S. Patent Office, July 30, 1885.]

9143

9144

DEPARTMENT OF THE INTERIOR, 9145

UNITED STATES PATENT OFFICE,

Duplicate. Washington, D. C., July 30th, 1885.

In the matter of the Application of THOMAS A. EDISON, "Electric Lights" Filed Decr. 11, '79.	Interlocutory Appeal.

9146

SIR: You are hereby informed that the hearing on the above appeal has been continued to Friday, August 28th 1885, at 1 P. M.

9147

By direction of the Commissioner.

Very respectfully,
SHUYLER DURYEE,
Chief Clerk.

THOMAS A. EDISON,
Care Richd. N. DYER,
No. 65 5th. Ave. N. Y. City.

[Endorsed: No. 146-30; paper No. 17; notice of postponement; dated July 30, 1885.] 9148

9149

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

Duplicate. Washington, D. C., August 27th, 1885.

In the matter of the 9150 Application of THOMAS A. EDISON, "Electric Lights" Filed Dec. 11, 79.	Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Tuesday
9151 Sept. 29th, 1885, at 11 A. M.

By direction of the Commissioner:

Very respectfully,

SCHUYLER DURYEE,

Chief Clerk.

THOMAS A. EDISON,

Care R. N. DYER,

No. 65 5th. Ave. N. Y. City.

9152 [Endorsed: Serial No, 146-30; paper No. 18; notice of postponement. dated Aug. 27, 1885.]

9153

Duplicate.

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., Sept. 23rd, 1885.

In the Matter of of The application of THOMAS A. EDISON. "Electric Lights." Filed, Dec. 11, '79.	Interlocutory Appeal. 9154

SIR:—You are hereby informed that the hearing on the above appeal has been continued to Friday October 16, 1885, at 1 P. M.

By direction of the Commissioner. 9155

Very respectfully,

SCHUYLER DURYEE,

Chief Clerk.

THOS. A. EDISON,

Care DYER & SEELY,

65 5th Ave.,

N. Y. City.

[Endorsed—No. 146—30; Paper No. 19; Notice of Postponement; Dated Sept. 23, 1885]. 9156

9157

Duplicate.

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., Oct. 19th, 1885.

In the Matter of The application of THOMAS A. EDISON. "Electric Lights." Filed, Dec. 11, '79.	Interlocutory Appeal.

9158

SIR:—You are hereby informed that the hearing on the above appeal has been continued to Tuesday November 17th, 1885 at 11 A. M.

9159

By direction of the Commissioner:

Very respectfully,

SCHUYLER DURYEE,
Chief Clerk.

THOS. A. EDISON,
Care DYER & SEELY,
65 5th Ave.,
N. Y.

9160

[Endorsed—No. 146—30; Paper No. 20; Notice of Postponement; Dated Oct. 16, 1885; Dec. 17, '85, 11 A. M.]

9161

Duplicate.

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON D. C., Nov. 18th, 1885.

In the Matter of The application of THOMAS A. EDISON. "Electric Lamps." Filed, Dec.11, '79.	Interlocutory Appeal. 9162

SIR:—You are hereby informed that the hearing on the above appeal has been continued to Thursday, December 17th, 1885, at 11 A. M.

By direction of the Commissioner: 9163

Very respectfully,

M. GARDNER,
Acting Chief Clerk.

THOS. A. EDISON,
Care R. N. DYER,
65 5th Ave.,
N. Y. City.

9164

[Endorsed—No. 146—30; Paper No. 21; Notice of Postponement; Dated Nov. 18, 1885.]

9165 Duplicate.

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE,

Washington, D. C., Dec. 15th, 1885.

In the matter of the
9166 Application of
THOS. A. EDISON,
Filed Dec. 11, 1879.
} Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Tuesday, Jan. 19th, 1886, at 12 M.

9167 By the direction of the Commissioner:

Very respectfully,
SCHUYLER DURYEE,
Chief Clerk.

THOS. A. EDISON,
Care R. N. DYER,
No. 65 5th Ave.
N. Y. City.

9168 [Endorsed: No. 146-30; paper No. 22; notice of postponement; dated Dec. 15, 1885.]

(Duplicate.) 9169

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., Jan'y. 19th., 1886.

In the matter of the
Application of 9170
THOMAS A. EDISON,
Electric lamps and
Methods of Making the Same.
Filed Dec 11, 1879.
} Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Friday, February 19th, 1886, at 12 M. 9171

By direction of the Commissioner:

Very respectfully,
SCHUYLER DURYEE,
Chief Clerk.

THOS. A. EDISON, 9172
Care R. N. Dyer,
65 5th Ave.,
N. Y. City.

[Endorsed:—No. 146-30; Paper No. 23; notice of postponement; dated January 19, 1886.]

9173

(Duplicate.)

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., Feby. 11th, 1886.

In the matter of the Application of Thomas A. Edison, "Electric Lamp and Method of Making the Same," Filed Dec. 11, 1879.	Interlocutory Appeal.

9174

SIR: You are hereby informed that the hearing on
9175 the above appeal has been continued, as per oral request, to Tuesday, May 18th, 1886, at 12 M.

By direction of the Commissioner:

Very respectfully,
SCHUYLER DURYEE,
Chief Clerk.

THOS. A. EDISON,
Care R. N. Dyer,
9176 65 5th Ave,
N. Y. City.

[Endorsed: 146-30; paper No. 24; notice of postponement; dated Feby. 11, 1886.]

Duplicate. 9177

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., May 17th, 1886.

In the Matter of The Application of THOMAS A. EDISON. "Electric Lamps." Filed Dec. 11, 1879.	Interlocutory Appeal.

9178

Sir—You are hereby informed that the hearing on the above appeal has been continued to Friday, June 18th, 1886, at 12 M. 9179

By direction of the Commissioner.

Very respectfully,
SCHUYLER DURYEE,
Chief Clerk.

THOS. A. EDISON,
Care R. N. DYER,
65 5th Ave.,
N. Y. City. 9180

[Endorsed—No. 146—30; Paper No. 25; Notice of Postponement; Dated May 17, 1886.]

9181 Serial No.

Thomas A. Edison.

Electric Lights. Filed December 11th, 1879.

Commissioner of Patents:

Sir—In the above-named case I have to ask that the hearing on the appeal to the Commissioner in person,
9182 now set for the 18th inst., may be postponed one month from that date, since I find my engagements will not permit me to attend to the matter at present.

I trust there will be no objection to this postponement.

Respectfully,

Rich'd N. Dyer,
Atty. for Edison.

June 14th, 1886.

9183 [Endorsed—No. 146/30; Paper No. 26; Request; Filed June 15, 1886; U. S. Patent Office, Jun. 15, 1886.]

9184

Duplicate. 9185

DEPARTMENT OF THE INTERIOR.

United States Patent Office,
Washington, D. C., June 16th, 1886.

In the Matter of The Application of Thomas A. Edison "Electric Lamps." Filed Dec. 11, 1879. — Interlocutory Appeal. 9186

Sir—You are hereby informed that the hearing of the above appeal has been continued to Tuesday, July 20th, 1886, at 12 M. 9187

By direction of the Commission.

Very respectfully,

Schuyler Duryee,
Chief Clerk.

Thos. A. Edison,
Care R. N. Dyer,
64 5th Ave.,
N. Y. City.

[Endorsed—No. 146/30. Paper No. 27; Notice of Postponement; Dated June 16, 1886.] 9188

9189 (Duplicate.)

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., July 19th, 1886.

9190 In the matter of the Application of THOS. A. EDISON "Electric Lamps," Filed Dec. 11th, 1879. } Interlocutory Appeal.

9191 SIR: You are hereby informed that the hearing on the above appeal has been continued to Tuesday, September 21st, 1886, at 12 M.

By direction of the Commissioner:

Very respectfully,
SCHUYLER DURYEE,
Chief Clerk.

THOS. A. EDISON,
Care R. N. Dyer,
9192 65 5th Av.,
N. Y.

[Endorsed—No. 146—30; Paper No. 28; Notice of Postponement, Dated July 19, 1886.]

9193

THOMAS A. EDISON.

Electric Lights.

Filed Dec. 11, 1879.

COMMISSIONER OF PATENTS:

SIR: It is requested that the hearing before the Commissioner in this case may be postponed one month.

Respectfully, 9194
RICH'D N. DYER,
Att'y for Edison.

Aug. 28, 1885.

[Endorsed—$\frac{146}{30}$ 29. Aug. 27, '86. Request for Postponement; Sept. 29, 1885, 11 A. M.; U. S. Patent Office, Aug. 27, 1886.]

9195

9196

9197 (Duplicate.)

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., Sept. 22, 1886.

In the matter of the application of

9198 THOMAS A. EDISON
" Electric Lamps,"
Filed Dec. 11, 1879.
} Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Friday, November 19th, 1886, at 12 M.

9199 By direction of the Commissioner:

Very respectfully,
SCHUYLER DURYEE,
Chief Clerk.

THOMAS A. EDISON,
Care R. N. Dyer,
65 5th Av.,
New York.

9200 [Endorsed—No. 178; Paper No. 30; Notice of Postponement, Dated Sept. 22d, 1886.]

9201

NEW YORK, Nov. 15, 1886.

COMMISSIONER OF PATENTS:

SIR:—In the matter of the application of Thomas A. Edison, relating to Electric Lights, filed Dec. 11, 1879, on appeal to the Commissioner in person, I have to request a postponement of the time set for hearing for one month from the date last set, since my engagements render it impossible for me to appear in the 9202
matter on that date.

Respectfully,
RICH'D N. DYER,
Atty for Edison.

[Endorsed—No. 146—30; Paper No. 31; Request; Filed Nov. 16, 1886; United States Patent Office, Nov. 16, 1886.

9203

9204

9205

Duplicate.

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., Nov. 18th, 1886.

In the Matter of The application of THOMAS A EDISON. "Electric Lamps." Filed, Dec. 11, 1879.	Interlocutory Appeal

9206

SIR:—You are hereby informed that the hearing on the above appeal has been continued to Wednesday,
9207 December 22nd, 1886, at 12 M.

By direction of the Commissioner:

Very respectfully,

SCHUYLER DURYEE,
Chief Clerk.

THOS. A. EDISON,
Care R. N. DYER,
9208 65 5th Ave.,
N. Y. City.

[Endorsed—No. 146—30; Paper No. 32; Notice of Postponement; Dated Nov. 18, 1886.]

9209

Duplicate.

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., December. 22, 1886.

In the Matter of The application of THOMAS A. EDISON. "Electric Lamps." Filed, Dec. 11, 1879.	Interlocutory Appeal

9210

SIR:—You are hereby informed that the hearing on the above appeal has been continued to Tuesday, Janu-
ary 25, 1887, at 12 M. 9211

By direction of the Commissioner:

Very Respectfully,

SCHUYLER DURYEE,
Chief Clerk.

THOS. EDISON,
Care R. N. DYER,
N. Y. City.

[Endorsed—No. 146—30; Paper No. 33; Notice of 9212
Postponement; Dated Dec. 22, 1886.

9213

New York, Jan. 24, 1887.

COMMISSIONERS OF PATENTS:

Sir: In the matter of the appeal to the Commissioner in the application of Thomas A. Edison, filed Dec. 11, 1879 in which a hearing was appointed for the 25th inst. I have to ask a further postponement of the hearing since my engagements will not permit
9214 my attendance on the day set. I would like a postponement of at least one month.

Respectfully,

RICH. N. DYER,
Atty. for Edison.

[Endorsed: 146—30; Paper 33½; Request; Filed Jan. 25, 1887; U. S. Patent Office, Jan. 25, 1887.]

9215

9216

DEPARTMENT OF THE INTERIOR, 9217

UNITED STATES PATENT OFFICE,

Washington, D. C., January 25, 1887

Duplicate.

In the matter of the Application of THOMAS A. EDISON, "Electric Lamps." Filed Dec. 11, 1879.	Interlocutory Appeal.

9218

SIR: You are hereby informed that the hearing on the above appeal has been continued as per request to 9219
Friday, February 25, 1887, at 12 M.

By direction of the Commissioner:

Very respectfully,

SCHUYLER DURYEE,
Chief Clerk.

THOMAS A. EDISON,
Care R. N. DYER,
40 Wall St., N. Y.

[Endorsed: 146—30; Paper No. 34; Notice of Post- 9220
ponement; dated Jan. 25th, 1887.]

9221

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE.

Duplicate. Washington, D. C., February 24, 1887.

In the matter of the
9222 Application of
THOMAS A. EDISON,
"Electric Lamps."
Filed Dec. 11, 1879.
} Interlocutory Appeal.

SIR: You are hereby informed that the hearing on the above appeal has been continued to Tuesday,
9223 April 26, 1887, at 12 M.

By direction of the Commissioner:

Very respectfully,

SCHUYLER DURYEE,
Chief Clerk.

THOMAS A. EDISON,
Care R. N. DYER,
40 Wall St. N. Y. City.

9224 [Endorsed: Filed Dec. 11, '79; Paper No. 35; Notice of Postponement; Dated Feb. 24, 1887.]

9225

Duplicate.

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., April 21, 1887.

In the Matter 9226
of
The Application of
THOMAS A. EDISON,
"Electric Lamps,"
Filed Dec. 11, 1879.
} Interlocutory Appeal.

9227

SIR: You are hereby informed that the hearing on the above appeal has been continued to Tuesday, June 28, 1887, at 12 M.

By direction of the Commissioner:

Very respectfully,

SCHUYLER DURYEE,
Chief Clerk.

THOMAS A. EDISON, 9228
Care R. N. Dyer,
40 Wall St., N. Y. City.

[Endorsed—Filed Dec. 11, '79; Paper No. 36; Notice of Postponement; Dated Ap. 21, 1887.]

9229 Duplicate.

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., June 28, 1887.

9230 In the Matter of the
Application of
THOMAS A. EDISON,
"Electric Lamps & Method of
Making the Same,"
Filed Dec. 11, 1879.
} Interlocutory Appeal.

9231 SIR: You are hereby informed that the hearing on the above appeal has been continued, as per request, to Thursday, July 28th, 1887, at 12 M.

By direction of the Commissioner:

Very respectfully,
M. GARDNER,
Acting Chief Clerk.

THOS. A. EDISON,
9232 Care Dyer & Seely,
40 Wall St., N. Y.

[Endorsed—No. 146—30 Paper No. 37; Notice of Postponement; Dated June 28, 1887.]

Duplicate. 9233

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFEICE,

WASHINGTON, D. C., July 27, 1887.

In the Matter of the 9234
Application of
THOMAS A. EDISON,
Electric Lamps and Method of
Making the same.
Filed Dec. 11, 1879.
} Interlocutory Appeal.

9235

SIR: You are hereby informed that the hearing on the above appeal has been continued to Wednesday, September 28, 1887, at 12 M.

By direction of the Commissioner:

Very respectfully,
JAS. N. LIPSCOMB,
Chief Clerk.

THOMAS A. EDISON,
Care Dyer & Seely, 9236
40 Wall St., N. Y. City.

[Endorsed—No. 146—30 Paper No. 38; Notice of Postponement; Dated July 27, 1887.]

9237

NEW YORK, June 27, 1887.

COL. GEO. W. DYER.

DEAR SIR:—Will you please see Mr. Emory early to-morrow—Tuesday—morning and get a postponement of the hearing before the Commissioner in the *ex parte* Appeal in the application of T. A. Edison, No. 187, which is set for to-morrow morning.

Emory will no doubt consent to put it over another
9238 month.

Yours truly,

DYER & SEELY.

[Endorsed—No.—146/30; Paper No. 39; Request for Postponement; Filed July 28, 1887; Continued to July 28, 1887; U. S. Patent Office, June 28, 1887.]

9239

9240

9241

Duplicate. J. M. E.

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., September 28, 1887.

In the Matter of The application of THOMAS A. EDISON. Electric Lamps and Method of Making the same. Filed December 11, 1879.	Petition.

9242

SIR:—You are hereby informed that the hearing on the above petition has been continued to Friday, 9243
October 28, 1887, at 12 M.

By direction of the Commissioner:

Very Respectfully,

JAS. N. LIPSCOMB,
Chief Clerk.

THOS. A. EDISON,
Care R. N. DYER,
40 Wall St.,
N. Y. City. 9244

[Endorsed—No. 146—30; Paper No. 40; Notice of Postponement; Dated Sept. 28, 1887; Continued one month.]

9245

Duplicate. J. M. E.

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., October 22, 1887.

In the Matter

9246 of

The application of THOMAS A. EDISON. Electric Lamp and Method of Making the Same. Filed December 11, 1879. } Petition.

SIR:—You are hereby informed that the hearing on
9247 the above petition has been continued to Wednesday, November 30, 1887, at 12 M.

By direction of the Commissioner:

Very respectfully,

JAS. N. LIPSCOMB,
Chief Clerk.

THOMAS A. EDISON,
Care R. N. DYER,
9248 40 Wall St.,
N. Y. City.

[Endorsed—No. 146—30; Paper No. 41; Notice of Postponement; Dated Oct. 22, 1887.

9249

Duplicate. J. M. E.

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., November 30, 1887.

In the Matter

of 9250

The Application of THOMAS A. EDISON. Electric Lamp and Method of Making the same. Filed Dec. 11, 1879. } Interlocutory Appeal.

Sir—You are hereby informed that the hearing on the above appeal has been continued to Friday, December 30, 1887, at 12 M. 9251

By direction of the Commissioner:

Very respectfully,

JAS. N. LIPSCOMB,
Chief Clerk.

THOS. A. EDISON,
Care R. N. DYER,
40 Wall st.,
N. Y. City. 9252

[Endorsed—Thos. A. Edison; No. 146-30; Paper No. 42; Notice of Postponement; Dated Nov. 30, 1887.]

9253

Duplicate. J. M., E.

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., December 31, 1887.

In the Matter

9254 of

The Application of THOMAS A. EDISON. Electric Lamps and Method of making the same. Filed Dec. 11, 1879. } Interlocutory Appeal.

Sir—You are hereby informed that the hearing on the above appeal has been continued to Wednesday,
9255 January 18th, 1888, at 12 M. You are also informed that there will be no further continuance without good an sufficient showing.

By direction of the Commissioner.

Very respectfully,

JAS. N. LIPSCOMB,
Chief Clerk.

THOS. A. EDISON,
9256 Care of R. N. DYER,
40 Wall st., N. Y.

[Endorsed—Thos. A. Edison; No. 146-30; Paper No. 43; Notice of Postponement; Dated December 31, 1887.]

Duplicate. J. M., E. 9257

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., February 27, 1888.

In the Matter

of 9258

The Application of THOMAS A. EDISON. Electric Lamps and Method of Making the same. Filed Dec. 11, 1879. } Interlocutory Appeal.

Sir—You are hereby informed that the decision of the Commisioner on the above appeal is as follows:
"The request for a declaration of an interference 9259
"with the patent of Sawyer and Man is denied, for
"the reason stated by the Examiner."

By direction of the Commissioner.

Very respectfully,

JAS. N. LIPSCOMB,
Chief Clerk.

THOS. A. EDISON,
Care of R. N. DYER, 9260
40 Wall st., N. Y.

[Endorsed—Thos. A. Edison; No. 146-30; Paper No. 44; Notice of Com'r's Decision; Dated Feb'y 27th, 1888.

9261

1879.

No.

THOMAS A. EDISON.

Assor. to The Edison Electric Light Company of New York N. Y.

Of Menlo Park

County of

State of New Jersey

Electric Lamps and Method of Making the same.

9262 Rec'd. Dec. 11, 1879.
Petition " " "
Affidavit " " "
Specification " " "
Drawing " " "
Model " " "
Cert. dep.
Cash $15. Dec. 11, 1879.
Add'l. Fee Cert.
" " Cash.

9262 Examined
Issue
Patented 187
Circular

HON. ROSCOE CONKLING.
Assoc.

DYER & WILBER,
Asso.
Washington, D. C. 9264

R. N. DYER,
Menlo Park,
New Jersey.

LEMUEL W. SERRELL.
Box. 4689.
New York, N. Y.

9265

1879.

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5 Int. $\frac{135}{73}$ Sep. 23, 1880 9266
6 Dec. 15, 1880, Amdt. "B D"
7 Jany. 28, 81 Motion to dissolve x denied
8 June 2, 83 Decd. favor Sawyer & Man
9 Mar. 11, 82. Amdt. E entd. Feb. 18, 85.
10 Feb. 19, 1885, Rej.
11 June 20, 85. Amdt. F.
12 " 27, 85 Rejected.
13 Interlocutory Appeal, July 11, 85.
14 Notice of hearing July 14, '85
15 July 30, 1885 Exs. Statement 9267
16 " 30, Req. for Postponement.
17 July 30, 85 Notice of
18 Notice of postponement Aug. 27, 85
19 " " " Sept. 23, 85
20 " " " Nov. 16, 85

TITLE.

Improvement in

36 Electricity, Electric Lights.

9268

9269 Serial No. 146 30 1884. Ex'r Book No. No. 137

Patent No.
T. A. Edison
Of
County of
State of
Invention Elec. Lamps & Method of Making the same.

Parts of application filed:
Petition
Affidavit
9270 Specification
Drawing
Model
Specimen
First fee Cash
" fee Cert.

App. filed complete Dec. 11, 1879
Examined
9271 Countersigned
For Commissioner.
Notice of allowance 188
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9272

1884. 9273

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24 Feb. 11, " " " "
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26 June 15, " Request.
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28 July 19, " " " "
29 Aug. 27, " Req. for Postpmt.
30 Sept. 22, " Notice of Postponement.
31 Nov. 16, " Request.
32 Nov. 18, " Notice of Postponement
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34 Jan. 25, " Notice of Postponement
35 Feb. 24, " " " "
36 Apl. 21, " " " " 9275
37 June 28, " " " "
38 July 27, " " " "
39 July 28, 1887 Request for Postponement.
40 Sept. 28, '87 Notice of Postponement

TITLE.

Improvement in
Edison $\frac{16}{30}$
No. 187

1884. 9276

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41 Oct. 22, '87 Notice of Postponement
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43 Dec. 31, '87 " " "
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9277

Defendant's Exhibit, Edison Consolidation Proceedings.

AGREEMENT made this 27th day of October, A. D., 1886, by and between The Edison Electric Light Company, hereinafter called the Light Co., and
9278 Charles Batchelor, Henry W. Barnes, Thomas C. Buck, C. T. Christensen, Charles H. Coster, Eugene Crowell, Thomas A. Edison, Frank S. Hastings, A. Foster Higgins, Edward H. Johnson, John C. Tomlinson, Spencer Trask and Richard N. Dyer, the Trustees of such corporation, parties of the first part; and The Edison Company for Isolated Lighting, hereinafter called The Isolated Co., and Edward H. Johnson, Francis R. Upton, Anthony J. Thomas, Erastus Wiman and F. S. Smithers, the Trustees of such
9279 Corporation, parties of the second part; each of the said companies being a corporation organized under Chapter 40, Laws of 1848, State of New York, and the several acts amendatory thereof and supplemental thereto.

WHEREAS, The above-named corporations have been respectively organized for the business of owning manufacturing, operating and selling various apparatus in producing light, heat and power by electricity.

9280

WHEREAS, By an act of the Legislature of the State of New York entitled "An Act to authorize the consolidation of corporations, passed the 28th day of May, 1884, and any acts amending and extending the same, it is provided that any two or more corporations organized under any general law of this State, for the

9281

purpose of carrying on any kind of manufacturing business of the same or of a similar nature are authorized to consolidate into a single corporation; and

WHEREAS, The amount of the capital stock of each of the above-named constituent companies has been fixed and determined at the following amounts, to wit, the Light Co. at \$1,080,000, divided into 10,800 shares of the par value of \$100 each, and the Isolated Co. at \$1,000,000, divided into 10,000 shares of like par value, making the aggregate amount of capital so fixed and determined by such constituent companies \$2,080,000. 9282

NOW, THEREFORE, This agreement witnesseth that the said Light Co. and the Trustees thereof, as above mentioned; and the said Isolated Co. and the Trustees thereof, as above mentioned, do hereby mutually enter into and make an agreement under and in pursuance of the aforesaid Act of the Legislature of the State of New York, passed the 28th day of May, 1884, and any acts amending and extending the same, 9283 and prescribe, the following as the terms, conditions and mode of carrying the same into effect, that is to say:

First. The said two Companies shall be consolidated into a new Company, and the name of the said new Company shall be The Edison Electric Light Company.

Second. The number of Trustees of the said new 9284 Company shall be thirteen, and the names of the Trustees who shall manage the concerns of the new Company for the first year and until others shall be elected in their places, are as follows, to wit: Charles Batchelor, Thomas C. Buck, Charles H. Coster, Noah

9285 Davis, Thomas A. Edison, A. Foster Higgins, Edward H. Johnson, F. Smithers, Anthony J. Thomas, John C. Tomlinson, Spencer Trask, Erastus Wiman and J. Hood Wright.

Third. The term of the existence of the said new Company shall be forty-nine years.

Fourth. The principal part of the business of the
9286 said new Company within this State is to be transacted in the City and County of New York, where the principal office of the Company will be located, but a part of the business of the Company will be carried on outside of this State, in North America and South America.

Fifth. The amount of the capital stock of the said new Company is to be $1,294,200, divided into shares of the par value of $100 each, which capital is not
9287 larger in amount than the fair aggregate value of the property, franchises and rights of the two companies herein consolidated.

Sixth. The said capital of the new Company, to wit, $1,294,200, shall be and hereby is apportioned between the said consolidated companies as follows, to wit:

To The Edison Electric Light Company.... $996,500
To The Edison Company for Isolated Light-
9288 ing....... 297,700

Seventh. The distribution of the aforesaid amounts of stock between the two companies shall be made as follows viz:

9289

(1.) The amount of the capital stock of the new Company apportioned to the Light Co., as aforesaid, to wit, $996,500, shall be divided pro rata by the new Company among the stockholders of record of the Light Co. in proportion to the holdings of each of the said stockholders at the time of the closing of the books of the Light Co. previous to consolidation; that is to say, every stockholder in the Light Co. shall be entitled to as many shares of stock or fractional parts thereof in the new Company as cor- 9290
respond to the number of shares of stock, or fractional parts thereof, in the Light Co., standing in his name at the time of the closing of the books of the Light Co. previous to consolidation, for which certificates shall be issued by the new Company corresponding to those theretofore issued by the Light Co.

(2). The amount of the capital stock of the new Company apportioned to the Isolated Co. as aforesaid, to wit, $297,700, shall be divided pro rata by the 9291
new Company among the stockholders of record of the Isolated Co., in proportion to the holdings of each of said stockholders at the time of the closing of the books of the Isolated Co. previous to consolidation, as follows, to wit: Every stockholder in the Isolated Co. (save and except a single stockholder therein, viz: the Light Co., provision for which is made in the next succeeding subdivision hereof) shall be entitled to three-fourths as many shares of stock, or fractional parts thereof, in the new Company, as cor- 9292
respond to the number of shares, or fractional parts thereof, in the Isolated Co. standing in his name at the time of the closing of the books of the Light Co. previous to consolidation, for which Certificates shall be issued by the new Company corresponding to those theretofore issued by the Isolated Co., in the aforesaid proportion of three shares in the new Company for every four shares in the Isolated Co.

9293 (3). WHEREAS the Light Co. is a stockholder in the Isolated Co. to the amount of fifty-one per cent. of its capital stock; and WHEREAS, one of the conditions of this agreement is intended to be that the Light Co. shall forever waive its rights to participate in the stock of the new Company and in the apportionment thereof herein provided for; NOW, THEREFORE, IT IS AGREED that the Light Co. shall not be entitled to participate in the apportionment of the stock in the new Company, to be divided among the
9294 stockholders of the Isolated Co., as provided for in the next preceding subdivision of this instrument; and that the Light Co. will, and hereby does, forever waive its right to share in such participation, hereby forever releasing both the Isolated Co. and the new Company, and all stockholders therein, from any and all rights it may now or at any time hereafter possess in that regard, with the same force and effect as if its said stock in the Isolated Co. had been duly and legally surrendered and cancelled.

9295 (4). Before any of the stock in the new Company shall be delivered to any stockholder or subscriber to stock in either of the constituent Companies, he shall surrender his certificates in such constituent Company to the new Company, which shall thereupon be cancelled by the new Company, and Certificates of Stock in the new Company shall be issued in exchange therefor, in manner and proportion as above provided for in this agreement.

9296 Eighth: All obligations and contracts of each of the constituent Companies, of every nature and kind whatsoever, shall be and hereby are assumed by the new corporation.

IN WITNESS WHEREOF each of the constituent Companies to this agreement has caused its corporate seal to be hereunto affixed and this agreement to be signed

by its proper officers thereto duly empowered; and each of the Trustees of each of the said two constituent Companies has hereunto set his hand and seal. Done at the City of New York on the day and year first above named. 9297

THE EDISON ELECTRIC LIGHT COMPANY.

[SEAL] by EDWD. H. JOHNSON,
Prest.

ATTEST: F. S. HASTINGS, 9298
Secy.

THE EDISON COMPANY FOR ISOLATED LIGHTING.

[SEAL] by F. S. SMITHERS,
Vice-President.

ATTEST: F. S. HASTINGS,
Secy.

Chas. Batchelor,	Trustee of the Light Co.	9299
H. W. Barnes,	" " " " "	
Thos. C. Buck,	" " " " "	
C. T. Christensen,	" " " " "	
C. H. Coster	" " " " "	
Eugene Crowell,	" " " " "	
Thos. A. Edison,	" " " " "	
F. S. Hastings,	" " " " "	
A. Foster Higgins,	" " " " "	
E. H. Johnson,	" " " " "	
John C. Tomlinson,	" " " " "	9300
Spencer Trask,	" " " " "	
Richard N. Dyer,	" " " " "	
E. H. Johnson,	Trustee of the Isolated Co.	
Francis R. Upton,	" " " " "	
Anthony J. Thomas,	" " " " "	
Erastus Wiman,	" " " " "	
F. S. Smithers,	" " " " "	

9301 The Minutes of a Special Meeting of the Stockholders of the Edison Electric Light Company, held at its office, Nos. 16 and 18 Broad St., New York City, on Wednesday, the eighth day of December, 1886, at twelve o'clock, noon, in pursuance of the following notices, a copy of which was addressed to each of the Stockholders of the said Company, and deposited in the Post Office, in the City of New York, with the full postage thereon prepaid, more than thirty days prior to the said 8th day of December; and such notice was
9302 also published for at least three successive weeks in the New York World, a newspaper published in the City of New York, the notice being as follows :

"Office of

"THE EDISON ELECTRIC LIGHT COMPANY

"Nos. 16 and 18 Broad St., N. Y. City.

"October , 1886.

9303 "A Special Meeting of the Stockholders of the Edison Electric Light Company will be held at the office of the Company, Nos. 16 and 18 Broad St., New York City, on Wednesday, the 8th day of December, 1886, at twelve o'clock noon.

"The object of the Meeting is to submit to the Stockholders for their action, an Agreement providing for the consolidation of the Edison Electric Light Company with the Edison Company for Isolated Lighting into a new Company to be known as
9304 the Edison Electric Light Company as provided for in the said agreement.

"By order of the Board of Trustees,

"F. S. HASTINGS,

"Secretary"

9305

STATE OF NEW YORK, City and County of New York, } ss.:

FRANK A. MASON, being duly sworn, says that he resides in Kings County, State of New York, that he is employed in the office of the Treasurer of the Edison Electric Light Company, at the offices of the said Company, Nos. 16 and 18 Broad St., New York City, that he addressed a copy of the annexed notice, calling a special meeting of the stockholders of the said Company, to each of the said stockholders at their 9306
place of residence, known to the Secretary of the Company and on record in his office, and, further, that he deposited the said notices thus addressed, postage paid, in the Post Office of the City of New York, on Wednesday, the 27th day of October, 1886.

F. A. MASON.

Sworn to before me this 8th day of Dec., 1886.

DAN'L RUMBOLD,
Notary Public, N. Y. Co. (41) 9307

STATE OF NEW YORK, City and County of New York, } ss.:

I, JAMES A. FLACK, Clerk of the City and County of New York, and also Clerk of the Supreme Court for the said City and County, the same being a Court of Record, do hereby certify, that Dan'l Rumbold, before whom the annexed deposition was taken, was at the time of taking the same, a Notary Public of New York, dwelling in said City and County, duly appointed and sworn, and authorized to administer oaths to be used in 9308
any Court in said State, and for general purposes; that I am well acquainted with the handwriting of said Notary, and that his signature thereto is genuine, as I verily believe.

[SEAL] In testimony whereof, I have hereunto set my hand and affixed the seal of the said Court and County, the 31 day of Dec., 1886.

JAMES A. FLACK, Clerk.

9309

STATE OF NEW YORK,
City and County of New York. } ss.

JEROME BUCK, Jr., of said City, being duly sworn, says that he is, and during the whole time hereinafter mentioned, has been the principal Clerk of the Publisher of "*The World*," a newspaper printed in the City of New York, and that the Notice, of which the annexed is a copy, was published in the said newspaper once in each week, for four weeks successively, commencing on
9310 the 10th day of November last past.

JEROME BUCK, JR.

Sworn to before me this
8th day of December, 1886.

WILLIAM SHIMER,
Com. of Deeds.

Office of
THE EDISON ELECTRIC LIGHT COMPANY.
9311 Nos. 16 and 18 Broad St.,
NEW YORK, Oct. 18, 1886.

A Special Meeting of the stockholders of the Edison Electric Light Company will be held at the office of the Company, Nos. 16 and 18 Broad St., New York City, on Wednesday, the 8th day of December, 1886, at 12 o'clock noon. The transfer books of the Company will close on Thursday, Nov. 25, at 3 P.M., and reopen on Thursday, Dec. 9, at 10 A.M. The object of the meeting is to submit to the stockholders for their action an
9312 agreement providing for the consolidation of the Edison Electric Light Company with the Edison Company for Isolated Lighting into a new Company to be known as the Edison Electric Light Company, as provided for in the said agreement.

By order of the Board of Trustees.

F. S. HASTINGS,
Secretary.

9313
The meeting was organized by the election of Mr. E. H. Johnson as Chairman, and Mr. S. B. Eaton as Secretary.

The above notice calling the meeting, also the above proof of mailing a copy of the said notice to each stockholder, also the above proof of publication of the same, were then read by the Secretary.

A list of the stockholders of the Company was then presented by the Secretary of the Company, and upon a call of the roll of stockholders it appeared that 202 9314
stockholders representing 7,616 shares out of the total of 10,000 shares of capital stock were represented in person or by proxy. The following stockholders were also present at the meeting in person, viz: Charles H. Coster, Edward H. Johnson, Charles Batchelor and Floyd Bailey.

The Chairman then stated that the object of the meeting as stated in the notice calling the same was for the stockholders to consider the question of consolidating with the Edison Company for Isolated Lighting, and 9315
more particularly to take action upon an agreement dated the twenty-seventh day of October, 1886, between the Edison Electric Light Company and the Trustees thereof, and the Edison Company for Isolated Lighting, and the Trustees thereof for the consolidation of the said two Companies into a new Company, to be known as the Edison Electric Light Company, which agreement had already been executed by all of the Trustees of each of the said two Companies.

The aforesaid agreement, as already executed, was then presented to the Chairman by the Secretary, of 9316
the Edison Electric Light Company. The Secretary of the Stockholders' Meeting then proceeded, at the request of the Chairman, to read the said agreement in full.

The terms of the agreement were then discussed, after which, on motion of Mr. Coster, the meeting proceeded to vote on the question of sanctioning and approving the agreement.

9317 The Chairman announced that pursuant to the provisions of the Statute, the vote would be by ballot, and he appointed Mr. Henry Reimer and Mr. Edward Clark to act as Tellers, to receive, examine and count the votes. The said two Tellers were then sworn as appears by the following affidavit:

STATE OF NEW YORK, }
City and County of New York, } ss.

WE, HENRY REIMER *and* EDWARD CLARK, do solemnly,
9318 sincerely and truly swear that we will perform the duties of Tellers at the Special Meeting of the Stockholders of the Edison Electric Light Company, to be held at the office of the Company, Nos. 16 and 18 Broad Street, in the City of New York, this 8th day of December, 1886, and that we will not receive any vote but such as we believe to be legal.

HENRY REIMER.
EDWARD CLARK.

Sworn to and subscribed before }
9319 me this 8th day of December, }
1886. }

DANIEL RUMBOLD,
Notary Public.
N. Y. Co. (41).

The Chairman then stated at a quarter past 12 P. M. that the polls were open for the purpose of receiving votes, and that they would remain open one hour, that is to say until quarter past 1 P. M.

The stockholders or those representing them by
9320 proxy then proceeded to vote by ballot on the question whether the agreement which had been read should be sanctioned and approved; and the Tellers proceeded to receive, examine and count the votes in the presence of the meeting.

The polls remained open one hour, until quarter past one P. M., at which hour they were declared closed. The count was then finished by the Tellers who announced that stockholders holding seven thousand six hundred and sixteen shares (7,616) and

9321
ninety-four hundredths of a share, being the entire amount of stock represented at the meeting either by stockholders in person, or by stockholders represented thereat by proxy, and further being more than two-thirds in amount of the entire capital stock of the Company, had voted in favor of the sanction and approval of the said agreement of consolidation. The Chairman then announced that the said agreement had by a unanimous vote of all the stockholders either present or represented at the meeting been duly sanctioned and 9322
approved, and upon motion being duly made and seconded and unanimously carried, the Secretary of this meeting was authorized and instructed to prepare a sworn copy of the proceedings of the meeting, in duplicate, and to attach the same to the duplicate originals of the said agreement of consolidation and to cause the same to be filed, one copy in the office of the Clerk of New York County, and the other copy in the office of the Secretary of State of the State of New York, all as required by law. 9323

The meeting then adjourned.

EDWD. H. JOHNSON,
Chairman.
S. B. EATON,
Secretary.

STATE OF NEW YORK, }
City and County of New York. } ss.:

S. B. EATON, being duly sworn says that he was Secretary of the Special Meeting of the stockholders 9324
of The Edison Electric Light Co. held on this 8th day of December, 1886, and that the above is a correct transcript of the proceedings had at said meeting, and of all of the same.

S. B. EATON.

Subscribed to before me this }
17th day of December, 1886. }

SAML. H. KINSLEY,
Commr. of Deeds,
City and County of N. Y.

9325

STATE OF NEW YORK,
City and County of New York. } ss.:

I, JAMES A. FLACK, Clerk of the City and County of New York, and also Clerk of the Supreme Court for the said City and County being a court of record, do hereby certify that Samuel H. Kinsley, before whom the annexed deposition was taken, was at the time of taking the same, a Commissioner of Deeds of New York, dwelling in said City and County, duly appointed and sworn, and authorized to administer oaths to
9326 be used in any Court in said State, and for general purposes; that I am well acquainted with the hand writing of such Commissioner, and that his signature thereto is genuine, as I verily believe.

In testimony whereof I have hereunto set [SEAL] my hand and affixed the seal of the said court and county, the 31 day of December, 1886.

JAMES A. FLACK, Clerk.

9327 The Minutes of a Special Meeting of the Stockholders of the Edison Company for Isolated Lighting, held at its office, Nos. 16 and 18 Broad St., New York City, on Thursday, the ninth day of December, 1886, at twelve o'clock, noon, in pursuance of the following notice, a copy of which was addressed to each of the stockholders of the said company and deposited in the Post Office in the City of New York, with the full postage thereon prepaid, more than thirty days prior to the said 9th day of December, and such notice was
9328 also published for at least three successive weeks in the *New York World*, a newspaper published in the City of New York, the notice being as follows:

"Office of
"THE EDISON ELECTRIC LIGHT COMPANY,
"Nos. 16 & 18 Broad St., N. Y. City,
"October , 1886.

"A Special Meeting of the Stockholders of the Edison Company for Isolated Lighting, will be held at

"the office of the Company, Nos. 16 & 18 Broad St., 9329
"New York City, on Thursday, the 9th day of December 1886, at twelve o'clock, noon.

"The object of the meeting is to submit to the "Stockholders for their action an agreement providing "for the consolidation of the Edison Company for "Isolated Lighting with the Edison Electric Light "Company into a new company to be known as the "Edison Electric Light Company as provided for in "the said agreement. 9330

"By order of the Board of Trustees.

"F. S. HASTINGS,
"Secretary."

The above notice calling the meeting was read together with the following proof of mailing the copies of the aforesaid notice to all the stockholders of the company, viz.:

STATE OF NEW YORK,
City and County of New York. } ss.:

GEORGE CLIFFORD RUSSELL, being duly sworn, says 9331
that he resides in the City of Brooklyn, State of New York, that he is employed as a clerk in the office of the Treasurer of the Edison Company for Isolated Lighting, at the office of the said company, Nos. 16 and 18 Broad Street, New York City, that he addressed a copy of the annexed notice calling a special meeting of the stockholders of the said company, to each of the said stockholders at their place of residence, known to the Secretary of the company and on record in his office,
and, further, that he deposited the said notices thus 9332
addressed, postage paid, in the Post Office of the City of New York on Friday, the 29th day of October 1886.

G. CLIFFORD RUSSELL.

Sworn to before me this 9th day }
of December, 1886, }

JOHN C. TOMLINSON,
Notary Public, N. Y. Co.

9333

STATE OF NEW YORK,
City and County of New York. } ss.:

I, JAMES A. FLACK, Clerk of the City and County of New York, and also Clerk for the Supreme Court for the said City and County, the same being a Court of Record, do hereby certify that John C. Tomlinson, before whom the annexed deposition was taken, was, at the time of taking the same, a Notary Public of New York, dwelling in said City and County, duly appointed and sworn, and authorized to administer oaths to be
9334 used in any Court in said State, and for general purposes; that I am well acquainted with the handwriting of said Notary, and that his signature thereto is genuine, as I verily believe.

In testimony whereof I have hereunto set my hand and affixed the seal of the said Court and County, the 31st day of Dec., 1886.

[SEAL]

JAMES A. FLACK, Clerk.

9335 The following proof of publication of the above notice was then read and filed, to wit:

STATE OF NEW YORK,
City and County of New York. } ss.:

JEROME BUCK, JR., of said City, being duly sworn, says that he is, and during the whole time hereinafter mentioned, has been the principal clerk of the publisher of "*The World*," a newspaper printed in the City of New
9336 York, and that the notice of which the annexed is a copy, was published in the said newspaper once in each week, for four weeks successively, commencing on the 11th day of November last past.

JEROME BUCK, JR.

Sworn to before me, this
8th day of Dec., 1886. }

WILLIAM J. SHIMER,
Com. of Deeds.

9337

Office of the Edison Company for Isolated Lighting, Nos. 16 and 18 Broad St., New York City, Nov. 11, 1886. A Special Meeting of the Stockholder of the Edison Company for Isolated Lighting will be held at the office of the Company, Nos. 16 and 18 Broad St., New York City, on Thursday, the 9th day of December, 1886, at 12 o'clock, noon. The transfer books of the Company will close on Friday, Nov. 26, at 3 P. M., and re-open on Friday, Dec. 10, at 10 A. M. The object of the meeting is to submit to the Stockholders for
their action an agreement providing for the consolida- 9338
tion of the Edison Electric Light Company with the Edison Company for Isolated Lighting into a new company, to be known as the Edison Electric Light Company, as provided for in the said agreement.

By order of the Board of Trustees,

F. S. HASTINGS,
Secretary.

The meeting was organized by the election of Mr. J. H. Vail as Chairman, Mr. F. S. Hastings as Secre- 9339
tary.

A certified list of the stockholders of the Company, was then presented by the Secretary of the Company, and upon a call of the roll of stockholders it appeared that eight thousand five hundred and thirty-eight (8,538) shares out of the total of ten thousand (10,000) shares of the capital stock of the Company was represented in person or by proxy, and the following stockholders were present in person, viz.: Charles H. Coster, E. H. Johnson, J. H. Vail, F. S. Smithers, W. C. 9340
B. Kemp, and S. B. Eaton.

The Chairman then stated that the object of the meeting as stated in the notice calling the same, was for the stockholders to consider the question of consolidating with the Edison Electric Light Company, and more particularly to take action upon an agreement dated the 27th day of October, 1886, between the Edison Electric Light Company and the Trustees thereof,

9341 and the Edison Company for Isolated Lighting, and the Trustees thereof, for the consolidation of the said two companies into a new company, to be known as the Edison Electric Light Company, which agreement had already been executed by all the Trustees of each of the said two companies.

The aforesaid agreement as already executed was then presented to the Chairman by the Secretary of the Edison Company for Isolated Lighting. The
9342 Chairman then proceeded to read it in full.

The terms of the agreement were then discussed, after which, on motion of Mr. Eaton, the meeting proceeded to vote on the question of sanctioning and approving the agreement, the vote to be by ballot, and the polls to remain open one hour for the reception of the votes.

The Chairmon announced that pursuant to the provisions of the Statute, the vote would be by ballot, and he appointed Mr. Henry Reimer, and Mr. F. McGowan
9343 to act as inspectors to receive, examine, and count the votes.

The Chairman then stated that the polls were open, the hour of opening being at a quarter past twelve, P. M., and that the polls would remain open one hour, until a quarter past one, P. M.

The stockholders, or those representing them by proxy, then proceeded to vote by ballot on the question whether the agreement which had been read should be sanctioned and approved; and the Inspect-
9344 ors proceeded to receive, examine, and count the votes in the presence of the Meeting.

After the polls had been closed, which was done at quarter past one, P. M., and the count had been finished by the Inspectors, the count having been made in the presence of the Meeting, the Inspectors announced that stockholders holding eight thousand five hundred and thirty-eight (8,538) shares, being more than two-thirds in amount of the stockholders present at the meeting in person or represented thereat by

proxy, and further, being more than two-thirds in 9345
amount of the entire capital stock of the Company, had voted in favor of the sanction and approval, of the said agreement of consolidation, the same being a unanimous vote, every vote having been cast in favor of such sanction and approval.

The Chairman then announced and declared that the said agreement had been duly sanctioned and approved by a unanimous vote of all the stockholders present or represented at the meeting. 9346

The Secretary of this meeting, upon motion being duly made, seconded and unanimously carried, was then authorized and instructed to prepare a sworn copy of the proceedings of the meeting, in duplicate, and to attach the same to the duplicate originals of the said agreement of consolidation, and to cause the same to be filed, one copy in the office of the Clerk of New York County, and the other copy in the office of the Secretary of the State of New York, all as required by law. 9347

The meeting then adjourned.

J. H. Vail, Chairman.
F. S. Hastings, Secretary.

State of New York, }
City and County of New York. } ss.:

F. S. Hastings, being duly sworn, says that he was Secretary of the Special Meeting of Stockholders of The Edison Company for Isolated Lighting held on this [illegible]th day of December, 1886, and that the above is a correct transcript of the proceedings had at said 9348
meeting, and of all of the same.

F. S. Hastings.

Subscribed to before me this }
[illegible] day of December, 1886. }

Saml. H. Kinsley,
Commr. of Deeds,
City & Co. N. Y.

9349

Re-Consolidation of The Edison Electric Light Co., and The Edison Co. for Isolated Lighting. Affidavits of the President and Treasurer of both Companies.

City and County and State of New York, ss.:

FRANK S. HASTINGS, being duly sworn, deposes and says:

(1) I am Treasurer of The Edison Electric Light
9350 Company. I am also Treasurer of The Edison Company for Isolated Lighting. Both Companies are organized under Chapter 40, Laws 1848, State of New York, and the amendments thereto. I have occupied the position of Treasurer and Secretary of both of the said Companies for more than one year.

(2) A meeting of the stockholders of the said Light Co., was held in New York City on December 8th, 1886, to take action on the question of consolidating that Company with the said Isolated Company. The
9351 capital of the said Light Co. is $1,080,000, divided into 10,800 shares of stock of the par value of $100 each. There were represented at the said meeting, either in person or by proxy two hundred and two (202) stockholders representing seven thousand six hundred and sixteen (7,616) shares of stock out of the total capital of 10,000 shares. The proposed consolidation was unanimously approved at the meeting by the said 202 stockholders, there being no opposing vote. A report of the proceedings of the said meeting, verified
9352 pursuant to law, is prefixed to this affidavit.

(3) A meeting of the stockholders of the said Isolated Company was held in New York City on December 9th, 1886, to consider the question of consolidating with the said Light Company. The capital stock of the said Isolated Co., is $1,000,000, divided into 10,000 shares of the par value of $100 each. There were represented at the said meeting, either in person or by proxy, ninety-two (92) stockholders, representing eight thousand five hundred and thirty-eight (8,538) shares

9353

of stock, out of a total of 10,000 shares, all of which voted in favor of the consolidation, there being no opposition whatever.

(4) Although the capital of the two consolidating Companies aggregates $2,080,000., the capital of the new consolidated Company is fixed at only $1,294,200, divided into 12,942 shares of the par value of 100 each. Every shareholder of the Light Co. is to receive one share of stock in the new consolidated Company for every share of stock in said Light Co., that is to say, 9354
every stockholder in the Light Co., is entitled to as many shares of stock, or the fractional parts thereof, in the new Company, as corresponded to the number of shares of stock, or fractional parts thereof, in the Light Co., standing in his name. Thus there is, practically speaking, no increase or diminution of the capital stock of the Light Co., as regards the said consolidation. But as regards the said Isolated Co., the case is different, there being, practially speaking, an apparent reduction of capital as regards the Isolated Co., in 9355
connection with the consolidation. The amount of capital stock of the new Company which is apportioned to the Isolated Co., is only $297,700, that is to say, 2,977 shares, and these are to be distributed among the stockholders of the Isolated Co. in the following proportion, to wit: Every stockholder in the Isolated Co. (save and except one large stockholder, to wit, the said Light Co. which consents to waive its right to participate in the apportionment of stock in the new Company) shall be entitled to three-fourths of as many 9356
shares of stock, or fractional parts thereof, in the new Company, as correspond to the number of shares, of fractional parts thereof, in the Isolated Co. standing in his name. From this it appears that there is what might be called a diminution of the capital stock or the Isolated Co. in connection with the consolidation.

(5). The indebtedness of the said Isolated Company is $106,352.76. This indebtedness is offset by available

9357 assets far exceeding in value the said sum of $106,352.-76. In other words, the assets of the said Isolated Company far exceed its liabilities. The actual market value of the stock of the Isolated Co. prior to the consolidation and to the aforesaid reduction of capital as regards that Company was less than the par value of the same.

(6). The indebtedness of the said Light Co. is merely nominal not exceeding at the outside the sum of $35,000, which indebtedness is more than offset by
9358 available assets.

(7). The Consolidated Company will assume and take over the entire indebtedness and assets of the said two constituent Companies. The capital of the said Consolidated Company, which is $1,294,200, as aforesaid, will be sufficient for the proper purposes of the Company and be far in excess of all debts and liabilities of the Company.

F. S. Hastings.

9359 Subscribed and sworn to before me this 16th day of Dec., 1886.

Samuel H. Kinsley,
Comm'r. of Deeds,
City & Co. N. Y.

Re-Consolidation of the Edison Electric Light Co., and the Edison Company for Isolated Lighting. Affidavits of the President and Treasurer of both Companies.

9360 *City, County and State of New York*, ss.:

Edward H. Johnson, being duly sworn deposes and says:

(1). I am President of The Edison Electric Light Company. I am also the President of The Edison Company for Isolated Lighting. These two Companies are about being consolidated into a new corporation,

the agreement of consolidation between them which 9361
has been heretofore executed, together with the minutes of the meetings of the stockholders of the two Companies to vote on the question of the said consolidation, being hereto prefixed.

(2). I have read the subjoined affidavit of Frank S. Hastings, who is Treasurer of both the said constituent Companies, and the statements made by him are true.

(3). The capital of the proposed Consolidated Company, to wit, $1,294,200, will be sufficient for the proper 9362
purposes of the Company, and is largely in excess of all debts and liabilities of the Company. Neither of the Consolidating Companies has any debts secured by trust mortgages, nor will the proposed Consolidating Company have such debts. As regards The Edison Electric Light Company, one of the constituent Companies, there is no reduction of its capital in connection with the consolidation, but every shareholder in the said Company will receive as many shares of like par value in the new Consolidated Company as 9363
will correspond to his holdings in the said constituent Company, as regards the other constituent company, The Edison Company for Isolated Lighting, there is apparently a reduction of capital in connection with the proposed consolidation. This apparent reduction arises out of two facts, first, that the other constituent Company, to wit, The Edison Electric Light Co., which is a large stockholder in the Isolated Co., consents to allow its holding of stock in the other Company to be cancelled pursuant to the terms 9364
of agreement of consolidation, whereby the capital stock of the said Isolated Co. is apparently reduced to that extent; and, secondly, all the other stockholders in the said Isolated Co. are to receive only three-fourths as much stock in the new Consolidated Co. as they hold in the said Isolated Co. Thus there is an apparent reduction of capital as regards the Isolated Co., arising out of the

9365 said proposed consolidation. The actual market value of the stock of the said Isolated Co. prior to the proposed consolidation, and prior to the apparent reduction of capital, as aforesaid, was less than the par value of the same.

EDWD. H. JOHNSON.

Subscribed and sworn to before me this 16th day of Dec., 1886.

SAMUEL H. KINSLEY,
9366 Comm'r. of Deeds,
City & Co. N. Y.

STATE OF NEW YORK.

COMPTROLLER'S OFFICE.

ALBANY, December 20, 1886.

Believing from the foregoing statements and affidavits that the reduced capital of the Edison Electric Light
9367 Co. and the Edison Company for Isolated Lighting, under their consolidation as the Edison Electric Light Company, is sufficient for the proper purposes of the Consolidated Company, and is in excess of all debts and liabilities of the Consolidated Companies, and that the par value of the stock of the Edison Company for Isolated Lighting, prior to the consolidation and reduction of capital, was less than the par value of the same, I hereby approve of such reduction as is shown in the annexed papers.

9368

Witness my hand and seal of office this twentieth day of December, 1886.

[SEAL] C. R. HALL,
Dep. Comptroller.

Filed and Recorded, Dec. 31, 1886.
1 h. 20 m.

STATE OF NEW YORK, *City and County of New York.* } ss.: 9369

I, JAMES A. FLACK, Clerk of the said City and County and Clerk of the Supreme Court of said State for said County do certify, that I have compared the preceding with the original Consolidation of The Edison Electric Light Co. with the Edison Co. for Isolated Lighting forming the Edison Electric Light Co., on file in my office, and that the same is a correct transcript therefrom and the whole of such original.

In witness whereof, I have hereunto subscribed my name, and affixed my official seal, this 18th day of October, 1887. 9370

[SEAL] JAMES A. FLACK, Clerk.

Filed and Recorded Dec. 31, 1886.
1 h. 20 m.

9371

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9373
Defendant's Exhibit Agreement between Edison and Complainant of November 15th, 1878.

This agreement, made the fifteenth day of November, in the year one thousand eight hundred and seventy-eight, between THOMAS A. EDISON, of Menlo Park, New Jersey, party of the first part, and the EDISON ELECTRIC LIGHT COMPANY, a corporation created and existing under the laws of the State of New York, and hereafter
9374 called "The Company," party of the second part.

WITNESSETH: Whereas, the company has been organized with the view of becoming the owner of, and of making, using and vending, and licensing others to make, use and vend within the United States and other countries or colonies hereinafter mentioned, all the inventions, discoveries, improvements and devices of said Edison, made or to be made, in or pertaining to electric lighting, or relating in any way to the use of electricity for
9375 the purposes of power, or of illumination or heating, or relating to improvements in electric engines, or to the developing of electric currents by machines or otherwise, for any use or purpose, except electric telegraphy.

And whereas, the said Edison is willing and desirous, in order to obtain the means to continue his investigations in the subjects above named, to transfer, upon the terms heretofore agreed upon, and hereinafter fully set forth, all the right, title and interest in his said inventions, made or to be made, as herein provided, and
9376 the exclusive use thereof in the countries above named, together with all letters patent of the United States or Canada, and all letters patent, special grants, concessions or privileges of any other State or country of North or South America, excepting the possessions of Spain, which may be granted for any of said inventions, discoveries, devices or improvements.

Now, therefore, in accordance with said terms, and 9377
in consideration of the mutual agreements of the parties hereto, as herein set forth, they respectively agree with each other as follows:

First: - The said Edison hereby sells and assigns to the company the entire right, title and interest in and to all inventions, discoveries, devices and improvements which he has hitherto made pertaining to electric lighting or to the use of electricity for the purposes of power,
or of illumination or heating, or to improvements in 9378
electric engines, or to the developing of electric currents by machines or otherwise for the uses or purposes above mentioned, or any of them; and especially all inventions, discoveries, devices and improvements which are described in the following applications and caveats for patents of the United States, namely, an application in Case No. 156, dated October 5th, 1878, filed October 14th, 1878; applications in Cases No. 162 and No. 163, prepared by L. W. Serrell & Son, but not yet signed;
in caveats numbered 82, dated October 7th, 1878; 83, 9379
dated October 25, 1878; 84, dated October 12, 1878; and 85, dated October 25th, 1878; and also those which are described in a certain application, and the papers thereto pertaining for letters patent of the Dominion of Canada, dated October 25th, 1878; and does also agree that all other inventions, discoveries, devices and improvements of the character above described, and all improvements which he may make within the period of seventeen years from the date of this instrument shall
be deemed to have been made for, and shall belong to, 9380
the company; and that he will take all such steps as are provided in the third article hereof to secure to the company letters patent of the United States and Canada, and such letters patent or other special grants or concessions of any other State or country of North or South America, except the possessions of Spain, as can

9381 be secured from them, or any of them. It being specially understood and provided, however, that this agreement is not intended to convey or give any interest to the company in any invention designed or capable solely of being used in electric telegraphy, or to give any right of use for electric telegraphy, of any invention which may be applicable to that as well as to any of the other purposes which are the subject, as above named, of this agreement, but the right of use of
9382 any invention, discovery, apparatus or device contemplated by this agreement for electric telegraphy remains in said Edison, and the company agrees to grant, under any letters patent belonging to it, such licenses for his benefit as he may request for the business of electric telegraphy.

Second.—All inventions or discoveries of the character described in the first article hereof which may be made by said Edison within the first five years of the
9383 period above named, and all improvements which he may make during the same period upon any of such inventions, devices or improvements shall belong to the company without further consideration; but compensation shall be due for all inventions or improvements made after the expiration of said five years; and immediately upon the issue of any Letters Patent, grants, concessions or privileges for inventions, discoveries, devices or improvements made after the expiration of said five years, if the company desires to hold such inven-
9384 tions and patents, such compensation shall be due and payable, and if the parties are unable to agree within three months from the date of such Letters Patent, grant or concession, upon the amount and the time, conditions and manner of payment of such compensation, the same shall, upon the written demand of either party, be submitted to arbitration of two indifferent and disinterested persons, one to be chosen by each party,

with power to choose a third, and the decision of such 9385
arbitrators, or of a majority of them, shall be final and binding upon both parties.

Third—The said Edison agrees that, in respect to all the inventions and improvements herein provided for, he will promptly file, in the proper offices of the United States and Canada, such caveats as may be necessary, in the judgment of the company, to protect the same, and will also promptly thereafter file his applications in the same offices for Letters Patent there- 9386
for, with requests that such Letters Patent may be issued to the company, as sole owners thereof, whenever the law allows, and will, simultaneously with the filing of such caveats or applications, also deliver to the company special assignments to it of all the right, title and interest in and to such inventions and improvements.

And said Edison also agrees to prepare or cause to be prepared such drawings, models and specifications of the inventions and improvements provided for by this agreement, as may be necessary, in the judgment 9387
of the company, or as may be required by it, to describe and illustrate them fully, and to deliver the same, with all sketches or memoranda pertaining to them, to the company, and at all times, upon the request of the company, to make, execute and deliver to it all amended specifications, models, drawings or applications that it may reasonably require; and all new or other assignments that may be necessary to secure to the company the exclusive ownership of all the inventions, discoveries, devices and improvements intended by this agree- 9388
ment in their most perfected form, together with all papers required to secure reissues, renewals or extensions of Letters Patent, grants or concessions for any of them.

And said Edison agrees, from time to time as requested by the company, to take all such other measures as may be necessary to procure Letters Patent or

9389 other grants or concessions, protecting his inventions in such other states or countries of North or South America, except the posessions of Spain, and to assign to the company, immediately upon receipt of them, all such Letters Patent, grants, concessions or privileges which may be issued in the first instance directly to him; but the expense of all things done in accordance with the provisions of this agreement, except as otherwise specially provided in the fifth article hereof, are to be borne by the company.

9390 *Fourth.*—The said Edison agrees on behalf of and for the benefit of the company, to prosecute with his utmost skill and diligence, further necessary investigations and experiments upon the use of electricity for the purposes described in the first article, and to endeavor to discover and devise the best and most economical means, modes and apparatus for applying electricity to the purposes above named, and for rendering the means, modes or apparatus which he may have discovered or devised more useful, economical and convenient; and to perfect and complete all his inventions
9391 and improvements described in the first and second articles, and all such as may result from the further investigations and experiments herein provided for, as far and as fast as may be in his power.

Fifth.—The company hereby agrees to issue to said Edison two hundred and fifty thousand dollars of its capital stock of three hundred thousand dollars, and to pay him upon the execution of this agreement, the sum of thirty thousand dollars in cash—of which sum
9392 said Edison agrees to expend twenty-five thousand dollars, or so much thereof as may be necessary, in procuring and paying for the means and material required for the most effective prosecution of the investigations and experiments provided for in the fourth

article hereof, and in defraying all other charges at- 9393
tendant upon such investigations and experiments, as well as the legal or other expenses attendant upon the organization of the company, and the preparation and taking out of patents in the United States and Canada for his inventions already made and described in the caveats and applications above referred to.

Sixth.—The company further agrees, out of its first net earnings remaining after reserving fifty thousand dollars, or so much thereof as may be required to re- 9394
pay the sums paid in cash by the subscribers to its capital stock, to pay to the said Edison the further sum of one hundred thousand dollars in cash; and thereafter to pay him an annual royalty upon every light licensed or used with its consent under any of the patents of said Edison, of five (5) cents per light; and guarantees to pay in each year royalties to an amount not less than fifteen thousand dollars a year, if it has net income to that amount in that year from any source
provided, however, that the company shall have the 9395
option by notice given on the first of January in any year, to pay thereafter a yearly commutation of thirty thousand dollars in lieu of all royalties derived under patents of the United States and Canada; and the like option, upon a similar notice, to pay thereafter annually the sum of twenty thousand dollars in lieu of all royalties or income derived under patents, grants, concessions or other rights secured to it in the other States or countries above named.
9396

Seventh.—The company hereby covenants with the said Edison that it will, in so far as the same may be practicable and economical, seek with diligence and good faith to introduce, as extensively as possible in all the countries named in this agreement, the electric

9397 light produced by means and apparatusn ivented by said Edison, as well as to bring all such means and apparatus into like use for all the other purposes contemplated by this agreement.

Eighth.—The said Edison agrees, at the request o the company and at its expense, to execute and deliver, from time to time, such writings of further assurance, such separate instruments, making special assignments of the interest of any portion thereof conveyed hereby, or such special powers or authorities as for its conve-
9398 nience or interest it may desire to have separate from the general body of stipulations herein contained.

Ninth.—The several agreements and covenants of the parties hereto shall bind and shall enure to the benefit of, respectively, the executors, administrators and assigns of Edison and the successors of the company.

In Witness Whereof, the party of the first part has hereto set his hand and seal, and the party of the sec-
9399 ond part has hereto caused its corporate seal to be affixed, and its corporate name to be subscribed the day and year first above written.

THE EDISON ELECTRIC LIGHT COMPANY, by

Norvin Green, Pres. [L.S.]

THOMAS A. EDISON. [L.S.]

Signed, sealed and delivered in the presence of

9400 [L.S.] Francis R. Upton,
Charles Roth,

Attest: C. Goddard,
Sec'y.

9401

State of New York, City and County of New York. } ss:

On this fifteenth day of November, one thousand eight hundred and seventy-eight, before me personally came Norvin Green and Calvin Goddard, to me known to be respectively the persons described in and who executed the foregoing instrument as the President and Secretary respectively of the Edison Electric Light Company, the corporation described in and in whose 9402
behalf the same instrument was by them executed, and they severally acknowledged to me that they executed the same as the free act and deed of said company, for the uses and purposes therein mentioned, and thereupon the said Norvin Green, being by me duly sworn, said that he resided in the city of New York; that he was the President of the said Edison Electric Light Company, and that he signed the name of the said The Edison Electric Light Company and his own name as President thereof, by order of the Board of Direc- 9403
tors of said company; and the said Calvin Goddard, being by me duly sworn, said that he resided in the city of New York; that he was the Secretary of said The Edison Electric Light Company; that he knew the corporate seal of said company; that the seal affixed to the foregoing instrument was such corporate seal, and was affixed by him by order of the Board of Directors of said company, and by the like order he signed his own name to said instrument as Secretary
of said company. 9404

And on the same day before me personally came Thomas A. Edison, to me known to be the individual described in and who executed the foregoing instrument, and acknowledged to me that he executed the same for the uses and purposes therein mentioned.

In Witness Whereof, I have hereunto subscribed my name and affixed my official seal the day and year first above written.

Charles Roth,
[L.S.] Notary Public (67), N. Y. Co.

Defendant's Exhibit—Agreement Between the Complainant and Thomas A. Edison of March 8, 1881.

Agreement entered into this eighth day of March, 1881, between the Edison Electric Light Company, a corporation organized under the laws of the State of New York, and hereinafter called the company, party
9406 of the first part, and Thomas A. Edison, of Menlo Park, Middlesex County, State of New Jersey, party of the second part.

WITNESSETH

Whereas the company is by assignment from said Edison, the present owner of several inventions upon which Letters Patent have been granted or applied for relating to Electric Light, and is, by contract entitled to the ownership of all such other inventions as may
9407 be hereafter made by him during the period of five years from the twelfth day of January, one thousand eighth hundred and eighty-one, and is desirous of promoting and encouraging the manufacture, in a skillful and responsible manner of incandescent electric lamps to be used under the Letters Patent and inventions aforesaid.

And whereas the said Edison enjoys in an especial manner the confidence of the company in respect to
9408 skill, ability and integrity, so that the said company is willing, with such due safe-guards in respect to its future business as may be right and proper, to confer upon the said Edison the exclusive right of manufacturing in the United States incandescent lamps to be supplied to the licensees of the company in the United States, or under the conditions hereinafter expressed, for exportation to foreign countries for which the company does not own such inventions.

And whereas the said Edison is willing and desirous to engage in such business of manufacturing and to devote his best skill and ability, not only to producing the best article which is possible, having respect to durability and the quality of light and economy of maintenance, but also to reduce the price of the same from time to time to the company, preserving only a suitable manufacturer's profit, and to join with him Charles Bachelor, Francis R. Upton and Edward H. 9410
Johnson, who are expert and experienced persons, also enjoying the esteem of the company in the respects above named.

And whereas it is mutually conceded by the parties:

First.—That the said Edison and his associates must have such assurance of being continued in the exclusive manufacture above referred to as can properly be given to justify the expenditure requisite for providing the manufacturing plant needed to meet the 9411
demand of the company or its licencees for lamps at all times during the period of this contract, and

Second.—That the company cannot put the manufacture of its lamps wholly out of its control, that failure or inability of the said Edison to supply the demands of licensees might jeopardize the prompt or profitable introduction and adoption of the company's system throughout the United States. 9412

It is agreed as follows:

1. The company does hereby, subject to the stipulations hereinafter provided, license and agree to license the said Edison with the exclusive right to manufacture, within the United States, for consumption therein, the incandescent lamp now, or from time to time used in connection with the electric lighting

system of said Edison, owned by the company, and will not license the introduction into the United States to be used therein the same or similar lamps manufactured elsewhere or by any other parties as hereinafter provided.

II. Said license shall, unless terminated, or the exclusive character therein modified, as hereinafter pro-
9414 vided, continue during the life of all and each of the Letters Patent for inventions of said Edison owned by the company, under which said incandescent lamps may at any time, be made.

III. The said Edison agrees to keep himself prepared to supply, and to supply promptly, all demands by the licensees of the company within the United States for such lamps at a price not to exceed thirty-five cents per lamp, safely packed at a railway station
9415 ready for shipment, and from time to time to reduce such price as improvements in the art of manufacturing or other causes may make such a reduction possible, it being understood that at a price of thirty-five cents, a net profit of three cents per lamp may be made and is adequate, and that a greater profit may be made as the business of manufacturing may continue and develop.

It is further agreed that the said Edison will endeavor to reduce the cost of manufacturing the stand-
9416 ard lamp, and that whenever the cost thereof shall fall below thirty-two cents each, he will pay over to the company one-half the difference between that price and the actual cost of the lamps manufactured, and that on the first of January and first of July of each year, said Edison shall render to the company an accurate statement of the number of lamps manufactured during the preceding six months and the actual cost thereof, and if such actual cost shall be less than

thirty-two cents said Edison shall pay over to the company one-half the difference between such actual cost and thirty-two cents each for all lamps for which he may have received payment during the next preceding period of six months, and the company, by its officers and agents shall have free access at all times to the manufactory and books of the said Edison and all other books connected with the business thereof for the purpose of verifying the statements so made. In 9418
determining cost, the total manufacture or output during the six months whether for the company or for foreign export shall be taken into account and the average cost of all the lamps manufactured during said six months shall be taken as the actual cost of a lamp under this contract.

IV. The said Edison shall invest or procure to be invested in actual cash immediately not less than fifty thousand dollars ($50,000) for the establishment of a 9419
suitable manufactory capable of furnishing one thousand lamps complete during each and every working day in the year, the investment already made at Menlo Park for that purpose being taken as a part of the same, and will thereafter keep himself adequately prepared to supply lamps to the licensees of the company when called for in the manner hereinafter provided. In order, however, that the said Edison and his associates may not be under the necessity of making large expenditures for manufacturing plant in advance of the 9420
establishment of the Edison Electric Lighting System throughout the United States, or upon an uncertainty as to the amount of lamps that may be required by licensees of that system from time to time, it is further agreed that the company shall, whenever it grants licenses for the use of its lamps or system in any territory within the United States, give notice thereof to the said Edison with the name of the licensee, and

9421 will require from such licensee a notice of the number of lamps required by it for initial installation, and the time when (not less than three months after the date of such notice) the same shall be required, and the company will transfer to the said Edison full information thereof, and will also, upon his request, obtain, so far as possible such suitable security or payment in advance, in behalf of the said Edison, as will justify him
9422 in building such additional buildings or machinery as may be requisite to supply to such licensee, within the time notified, the lamps required for initial installation as well as for subsequent maintenance in the territory covered by the licensee, and thereupon it shall be the duty of the said Edison, on receiving due payment therefor, to supply at the time named to such licensee the number of lamps called for, and thereafter to keep such licensee fully and promptly supplied with all lamps required for maintenance in such territory. In
9423 all business connected with the supplying of lamps the company will act as the agent both of the licensee and of the said Edison. No order shall be received by the said Edison directly from any licensee; all orders shall pass through the company, and all drafts for payment shall be made upon the licensee through the company as such agent; all shipments and deliveries shall be made only under the direction and control of the company, but no compensation shall be charged to the said Edison for such service or intervention.

9424 V. It being essential for the protection of the interests of the company that its licensees, who are by this agreement virtually restricted to one manufacturing establishment for their supply of lamps, shall be nevertheless, at all times, able to procure the same of a suitable style, quality and character, with promptness and despatch, and that the company shall have full power to protect itself against being hindered or delayed in introducing its lighting system in all parts of the United States it is agreed:

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(1). That all lamps manufactured shall be of one or more standard sizes, styles and grades, to be fixed and determined by the company, and from time to time altered and modified by it, so as to enable the company to require the introduction from time to time of all possible improvements affecting either the style, economy, durability or other qualities of such lamp, provided, however, that any such change which shall make necessary the use of more material, or that which is 9426 more expensive, or shall enhance the labor of making or handling said lamps, shall be made the subject of a revision of price, preserving the same relative proportion of outlay and profit as is fixed above; and in case of failure of the parties to agree, the revision shall be made and fixed by a competent arbitration to be appointed in the manner provided for by the seventh article hereof.

(2.) That the diagrams and drawings hereto annexed 9427 marked Exhibit "A," are to be taken as establishing such standards for the purpose of this agreement, and until the same shall be modified by the company.

(3.) That the said Edison shall deposit with the company forthwith complete working drawings and models of such lamp in all its different forms as now made; and that thereafter, during the continuance of the contract, full and complete duplicates of the same, and working drawings and models of all improvements, 9428 changes or modifications thereunder, and of all machinery, tools and appliances of every kind employed by the said Edison or his associates in the manufacture of such lamps, or in any way connected with the manufacture of the lamps, or any part thereof, shall, with full specifications of the same, be promptly deposited with the company.

(4.) In case the said Edison shall fail to supply all
the lamps required by the licensees of the company, or
any of them, as the same shall be called for, the com-
pany shall have the right to manufacture, or cause to
be manufactured by others, such an amount of lamps
as may be, in its judgment, requisite not only to supply
the amounts in which the said Edison has been defi-
cient, but also to guard against future failure of simi-
9430 lar character. This stipulation is, however, intended
to have a reasonable interpretation, viewing all the
difficulties of the said Edison in building up a new
business in which unforseen obstacles may be encount-
ered, tending temporarily to embarrass him in the per-
formance of his contract without his fault, and also
viewing the necessity which the company is under to
make its territory promptly available by providing
ample resources from which its licensees may obtain
supplies; and with all these considerations in view, it
9431 is agreed that the company must necessarily be, and
shall be, left free to judge from time to time, acting
reasonably and with good faith, whether the resources
and management of the said Edison are such that he
is liable to fail in supplying the lamps which have
been or may be required by its licensees, and acting
upon such judgment, and in good faith, the company
shall have the right, after any failure by the said Edison
to make, or cause to be made by others, such amount
of lamps as may, in its judgment, be requisite to supply
9432 past deficiencies and to guard against the contingency
of future failure, and to sell and dispose of the same as
it may think proper; but it shall not have the right to
manufacture or authorize the manufacture of lamps
by other persons, except to such limited extent as may
or seem necessary for the purposes above set forth. In
contracting for lamps with any other manufacturer, in
providing means and appliances for such manufacture

by itself, it shall be at liberty to provide or contract
for such future supply as will justify the original out-
lay for plant to cover the actual or possible deficiency
sought to be guarded against.

VI. The said Edison shall have the right, without
royalty, to manufacture lamps for export to all foreign
countries, other than those in North and South Amer-
ica, but notice shall be given to the company of the 9434
time, place and amount of such exportation before
shipment of same from the manufactory, and the books
of entry or correspondence relating thereto shall in like
manner be, at all reasonable times, open to the inspec-
tion of the company. But this right to manufacture
for export shall not be allowed to interfere with the
prompt filling of orders given by the company or its
licensees, and the demands of that company shall
always take precedence of shipments to foreign coun-
tries. 9435

VII. Should the said Edison continue, after the ex-
piration of one year from the date hereof, during any
period of six successive months, to fail in supplying
the requirements of any one or more of the company's
licensees, it shall then be at the option of the com-
pany to terminate this exclusive license, but in that
case it shall, if required by the said Edison, take
over the manufactory and other property erect-
ed or provided by him for the purpose of such 9436
manufacture, at the actual cost thereof, with a fair al-
lowance for depreciation by use, such valuation, in case
the same cannot be agreed upon by the parties, to be
fixed by three competent appraisers, one to be chosen
by each party hereto and the other to be chosen by such
two. Should, however, the said Edison in the case pro-
vided for by this section, elect not to make such re-
quirement, it shall be the duty of the company to de-

liver the orders of its licensees to the said Edison for such amount or amounts of lamps as he may have furnished as his average daily output for the three months next preceding any notice by the company of its intention to terminate the exclusive license, but as to any excess which in its judgment may be required thereafter by the licensees of the company, it shall be free to manufacture or authorize the manufacture of the same by other parties as provided in the foregoing clauses.
9438

VIII. In case the said Edison shall supply or sell lamps to any person or corporation in the United States other than the licensees of the company, or except upon an order in each instance made by said licensee through the company or by the company itself; or shall fail to keep proper books of account for the purposes herein provided; or shall refuse access thereto, to the company's agents, at any proper and reasonable time, for the purpose of determining the
9439 cost of such manufacture, or shall fail to furnish models, working drawings and specifications and deposit the same promptly with the company, or shall delay the supply of the company's licensees by engaging in work for foreign countries without the consent in writing of the company, it shall be at the option of the company to revoke all licenses granted or arising hereunder.

IX. In case the company shall become the owner of any other letters patent or inventions or licenses therefor, or any tools, machinery or appliances useful
9440 in manufacture of such lamps, the company shall authorize the said Edison to make use of the same for the manufacture authorized by this contract during its continuance. Should the said Edison or any of his associates above named at any time hereafter become the owners, by purchase or otherwise, of any letters patent, or inventions or licenses therefor, or any tools,

machinery or appliances useful or necessary in the manufacture of such lamps, he or they shall license the company or such persons as, after failure of the said Edison referred to and provided for in the foregoing clauses hereof, the company may find necessary to employ for supplying the deficiencies above mentioned. It shall be an obligation of good faith binding upon the said Edison and whoever may be associated with him and derive benefit hereunder, to take all licenses 9342
or rights to use the inventions of others in such form as to be able to convey such rights of use to the company upon the contingency last above stated. Prompt notification shall be given by each party of every acquisition of the ownership or the right to use any letters patent capable of use in or about the manufacturing or handling of said lamp.

X. Whenever for the purpose of this agreement it shall, from time to time, be necessary to determine the 9443
actual cost of the manufacture of lamps packed and delivered for shipment as above described no compensation shall be allowed the said Edison, but there shall be allowed a fair and usual compensation for the actual services of the said Bachelor, Upton and Johnson, such as is customarily paid in manufacturing establishments for similar services, but no account shall be made of interest or investments either in plant or stock.

XI. In case the said Edison should, by reason of 9444
death, disability or any other cause, be unable or fail to give his personal skill, ability and experience to the manufacture of such lamps it shall be at the option of the company to terminate this contract and all licenses and privileges arising thereunder. But in case such failure shall be without the fault of the said Edison, the company shall purchase or procure to be purchased all his manufactory, works, machinery and appliances

9445

at a fair valuation to be appraised in case of disagreement between the company and the said Edison or his personal representatives by an arbitration in the manner provided by the seventh article hereof.

In Witness Whereof, the said Edison Electric Light Company has caused these presents to be subscribed by its president and its corporate seal to be hereunto affixed and attested by its secretary, and the party of
9446 the second part has hereunto set his hand and seal the day and year first above written.

THOMAS A. EDISON.

Witness to the signature of Thomas A. Edison,

Sam'l Insull.

[SEAL.]

9447 The Edison Electric Light Company.

by S. B. EATON,

Vice Prest.

Attest,

C. Goddard,

Secy.

9448

9449

Defendant's Exhibit Contract between the Complainant and the Edison Company for Isolated Lighting.

Contract between Parent Company and Isolated Company.

Agreement entered into this twenty-sixth day of April, 1882, between the Edison Electric Light Com- 9450
pany, party of the first part, hereinafter called the Light Company and the Edison Company for Isolated Lighting hereinafter called the Isolated Company, party of the second part, each being a corporation duly organized under the laws of the State of New York,

Witnesseth: Whereas, the Light Company is by virtue of two certain contracts with Thomas A. Edison, bearing date of November 15, 1880, and January 12, 1881, and of various assignments of letters patent thereunder the 9451
owner for the United States of America of certain inventions and letters patent upon inventions of the said Edison having reference to the generation, distribution and application of electricity to the production of light, heat and power, and is entitled by such contract to all the inventions of the said Edison relating to the same subjects for the same territory heretofore made or which hereafter may be made within the period of five years from January 12, 1881, and is desirous of contracting with the Isolated Company for exploiting, 9452
introducing and bringing into use all said inventions, so far as they may be applicable to the production of light, heat and power in buildings and places outside of gas limits as hereinafter defined; and

Whereas, The Isolated Company is by law empowered to undertake and carry on such business and is capable of making contracts relating thereto, and has

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engaged with the Light Company to use its best efforts to promote the introduction of the system of Electric Lighting owned by the Light Company, it is agreed as follows :

First. The Light Company will license the Isolated Company for the sole and exclusive use of all the inventions and letters patent of Thomas A. Edison, now belonging to the Light Company or which may here-
9454 after come ito its possession, under and pursuant to the two certain contracts heretofore executed between the Light Company and the said Edison, bearing date the fifteenth day of November, 1880, and the twelfth day of January, 1881, reference to which is herein made, and will execute and deliver to the Isolated Company a license in the form hereto annexed marked Exhibit "A" and such other or further license as the
9455 Isolated Company is entitled to demand under the terms of this agreement securing to it under the conditions herein set forth the sole and exclusive right to use and authorize to be used and employed the inventions and patents aforesaid in all parts of the United States of America being outside of gas limits, including all vessels plying within the waters of the United States, marine and inland, whether within or outside of gas limits, with power to the Isolated Company to grant licenses to all such persons or companies as may own or possess apparatus made under any of the in-
9456 ventions or letters patent aforesaid to employ the same in like manner and to transfer by license to any person or corporation any part or parts of the territory hereby conveyed for the use therein of all or any part of the inventions or letters patent aforesaid, provided, however, that no license for an entire State shall be given to the same licensee without the consent of the Light Company.

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Second. The term "gas limits," as herein used, means all those portions of the United States and the territories thereof, which on the first day of January, 1882, were included within the municipal limits of any town, city, village, or other territorial municipality wherein illuminating gas was or had, prior to that time, been supplied for purposes of lighting to more than ten customers or consumers ; and this agreement relates to all portions of the territory of the United States and 9458
the territories thereof not included in such gas limits, but does not apply to the propulsion or lighting of railway trains or the furnishing of power for railway traffic, the Light Company hereby reserving exclusively the right to deal with such railway lighting and traffic.

Third. The Isolated Company shall have the right, without the payment of any further or additional compensation, to make installations of isolated plant for 9459
lighting within gas limits, as above defined, until notified by the Light Company that a license has been granted to another person or company, for the territory in question, but this privilege shall not be deemed to come within the license herein provided for, but shall be subject to the control of the Light Company, to limit or terminate the same from time to time, as it may see fit, provided, however, that all rights already acquired within such gas limits by customers or 9460
purchasers shall remain intact notwithstanding such termination or limitation of the Isolated Company's temporary privileges as conferred by this Article and provided also, that the Isolated Company may complete the installation of such plants within such gas limits as may, before such notice, have been in good faith actually undertaken.

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Fourth. The Isolated Company shall have the privilege to manufacture any and all patented devices of the Light Company, except lamps, required for its business and covered by the Light Company's letters patents or purporting so to be, on the same terms as other manufacturers may be licensed by the Light Company; but except such articles and devices as may be thus manufactured by itself in its own shops, it shall
9462 purchase all such patented articles and devices as it may require from manufacturers holding the license of the Light Company for manufacturing, and nothing herein contained shall be deemed to prevent the Isolated Company from purchasing and using the letters patent or inventions of any other inventor not covered, or claimed by the Light Company to be covered, by the Light Company's letters patent. Such manufacture by the Isolated Company shall be under license, fixing the place of manufacture, the amount of royalty
9453 to be paid on each patented article covered by the license, and limiting the sale or use thereof to the kinds of business covered by this agreement and the license for use hereto annexed.

Fifth. The consideration paid by the Isolated Company, and to be received by the Light Company, for the license and privilege herein granted, is to be fifty-one one hundredth parts of all the property, assets and net profits of the Isolated Company, such shares in the profits to be paid by it at the same time, and in the
9464 same manner as dividends of net profits are made to its stockholders, and to be paid only on stock held by the Light Company or its assigns; and for the more convenient distribution and accounting for said net earnings, and as a means of representing the interest of the Light Company in the property and assets of the Isolated Company and as a settlement and payment *pro tanto* for the rights, property and privileges herein granted or agreed so to be, it is in pursuance of the

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understanding heretofore had between the Light Company and the promoters of the Isolated Company, further covenanted that the Isolated Company will, upon demand of the Light Company, issue to it fully paid shares of the Isolated Company's capital stock to the amount of twenty-five hundred and fifty shares which shall be taken and received by the Light Company as and for a part compensation for its convenants herein contained, the rights, privileges and property hereby 9466
conveyed; and whenever at any time the capital shares of the Isolated Company shall be increased, it shall issue and deliver to the Light Company fifty-one per cent. of all such increase in fully paid shares, to the end that of every one hundred shares of stock issued by the Isolated Company at any time, the Light Company shall be entitled to receive fifty-one shares fully paid as aforesaid. The stock so issued, both in case of the present capital as well as in case of any and all subsequent increase of capital shall be assignable by the 9467
Light Company at its option, the same as any other stock held by a stockholder may be assigned by him. But such assignment by the Light Company shall not be deemed to carry with it any right to the assignee, as a stockholder, to participate in the percentage of fifty-one one hundredths of stock coming to the Light Company in the event of any subsequent increase of the capital stock of the Company, but such stock shall have only the same rights, and privileges, and shall, in every respect, stand the same as all other stock of the 9468
Company in the hands of the stockholders for value.

Sixth. On the first days of January and July, in each year, the Isolated Company shall make a report to the Light Company of its business for the preceding six months, and the Light Company shall have the right by authority of its Board of Directors or its Executive Committee to examine the books and accounts of the

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Isolated Company at that time as well as at any other reasonable time, and for that purpose the Isolated Company shall offer suitable and customary facilities.

Seventh. Inasmuch as portions of the territory now outside of gas limits may hereafter, during the life of some or all the said letters patent, be brought within the municipal boundaries of a town, city or village, or other territorial municipality, it is further agreed that
9470 upon the happening of any such event, the license and privilege of the Isolated Company for such territory thus newly brought within such municipal limits shall cease and determine, and shall revert to the Light Company, to be managed, operated and disposed of by it solely; but all net gains and advantages in any way derived by the Light Company from the use of its letters patent or inventions within such new gas limits shall be paid to the Isolated Company for distribution among its stockholders, the object of this provision being to secure to the Light Company a power of establish-
9471 ing uniform rules and terms in respect to the lighting of cities or towns from central stations, without however taking from the Isolated Company its beneficial interest in any territory which it has once had any right to occupy under this agreement.

Eighth. The Light Company shall at all times give to the Isolated Company without further compensation the benefit of whatever contracts it may at any time have for lamps, dynamos, meters, regulators and other electrical apparatus or plant, without prejudice to the
9472 right of the Light Company at any time to change or cancel such contracts or any of them.

Ninth. The Light Company reserves to itself the right to prosecute and defend all suits or proceedings affecting the validity of its letters patent, and will upon notice from the Isolated Company, prosecute all

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infringers of said patents in the territory covered by this agreement whenever the Light Company, having in view its general interest in said inventions and letters patent, shall deem it judicious and proper to do so; and it is hereby agreed that whenever any action affecting the patents of the Light Company shall be commenced against the Isolated Company, or shall come to its notice, the Isolated Company shall immediately and without further delay, notify the Light Com- 9474
pany of the same, and if the Light Company does not elect to defend any suit commenced against the Isolated Company affecting the validity of its letters patent, the Isolated Company shall then be free to do so, subject to general control and direction of the Light Company should the latter thereafter choose to exercise such control, but in any case one-quarter part of the expense of such defense incurred by the Light Company shall be reimbursed to it by the Isolated Company. 9475

Tenth. The Isolated Company hereby covenants and agrees to proceed with promptness and diligence, to cause the inventions and letters patent of the Light Company and their application to the uses and purposes herein contemplated to be licensed to the Isolated Company to be generally and favorably known within all the United States and the territories thereof and for that purpose to employ all necessary agents, electricians and workmen, but for the facilitation of the 9476
business the Light Company agrees to furnish to the Isolated Company all models, drawings or directions owned or at any time in the possession of the Light Company for the installation and operation of the patented apparatus and appliances, and in every other way within its power to facilitate the business of the Isolated Company.

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In witness whereof, the parties hereto have caused these presents to be executed, the party of the first part by its President, and the party of the second part by its General Manager, thereto expressly authorized, and their respective corporate seals to be hereto affixed and attested at the City of New York the day and year first above written.

9478 THE EDISON ELECTRIC LIGHT CO.,

[SEAL] by S. B. Eaton,

Vice-Pres't.

Attest,

C. Goddard,

Sec'y.

9479 THE EDISON CO. FOR ISOLATED LIGHTING.

[SEAL] per M. F. Moore,

Gen'l Manager.

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Defendants' Exhibit – Supplemental Contract Between the Complainant and the Edison Company for Isolated Lighting.

This agreement, made the first day of September, 1884, by and between the Edison Electric Light Company, herein called the Light Co. of the first part; and the Edison Company for Isolated Lighting, herein 9482 called the Isolated Co. of the second part, each being a corporation created under the laws of the State of New York, and having its principal officein the City of New York,

Witnesseth: Whereas the Light Co. has heretofore made a certain agreement with the Isolated Company, dated the 26th of April, 1882; whereby certain rights and privileges are granted to the Isolated Company, relating to the business of exploiting the Edison system 9483 of electric light, heat and power, as more fully appears from the said agreement itself, reference to which is hereby made; and

Whereas the Light Co. now proposes to grant to the Isolated Co. still further rights and privileges touching the said business, and, more especially, to assign and turn over to the Isolated Co. during the continuance of this agreement, the Light Co.'s present business of exploiting the said Edison system of electric light, heat and power in all the ter- 9484 ritory belonging to the Light Co. in both the United States and Canada, as more fully appears in this instrument.

Now, therefore, in consideration of the premises and of the mutual promises herein made, It is hereby agreed and declared by and between the parties hereto as follows, that is to say:

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First.—The Light Co. agrees to appoint, and hereby does appoint the Isolated Co. its agent, as herein set forth, to exploit its business of electric light, heat and power, both central station and isolated, in all the Light Co.'s territory in the United States and Canada, for the period covered by, and subject to the terms and provisions of this agreement; and the Isolated Co. will and hereby does accept the said agency.

9486 *Second.*—The Light Co. will and hereby does license the Isolated Co. during the continuance of this agreement and no longer, and for all the territory in the United States and Canada not heretofore, or hereafter, transferred by the Light Co. to other licensees, to sell and install Edison plants for isolated lighting, and for central station lighting, together with all the appurtenances thereto belonging;
9487 also to promote the organization of local companies in cities, villages and towns, to introduce into practical use the said Edison system of electric light, heat and power, subject, however, to the provisions of this agreement, and to the approval of the Light Co. as herein provided for.

It is agreed that the license herein given to the Isolated Co., as well as that covered by the said license agreement of April 26th, 1882, is unassignable, and is granted to it as a privilege personal to itself, and is not to be assigned or transferred by it in any way, and
9488 that both this license agreement and that of April 26th, 1882, severally, may be forthwith and peremtorily terminated by the Light Co. in the following cases, viz: (1.) Upon the Isolated Co. ever making or attempting to make any assignment of either of said agreements, or of any of the rights or privileges thereby conceded to it, save and except as expressly provided for in the said two agreements, severally; or (2) upon any such assignment resulting by operation of law.

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Third.—The prices for all isolated plants shall be fixed by the Isolated Co., in its discretion. But the Light Co. reserves the right, touching the territory covered by this agreement, to determine from time to time, and in its discretion, the prices and terms for supplying central station plants, and the terms, conditions and restrictions for organizing local companies, as aforesaid, including capitalization, territorial area of license, size and type of installation, and all other de- 9490
tails therewith connected; and all licenses for such local companies shall always emanate from the Light Co., and be granted by it directly to each local company, without passing through the Isolated Co. While it is the intention of this contract that, in said territory no local company shall be formed, and no central station plant be contracted for or installed, unless with prior written approval of the Light Co., still it is assumed that the Light Co. will exercise its authority in good faith, and will not refuse to grant its approval 9491
except for good and substantial reasons. It is further agreed that the Isolated Co. is not compelled to organize local companies and supply central station plants, as aforesaid, if the conditions thus imposed by the Light Co., in its discretion, are not satisfactory to the Isolated Co.

Fourth.—During the continuance of this agreement, the Isolated Co. will, at its own expense, maintain a competent and adequate electrical and engineering 9492
staff, will, in good faith, make arrangements for securing sufficient material, and will otherwise in every way make adequate provision for promptly and successfully carrying on the business herein provided for. The Isolated Co. will also at its own expense employ competent executive officers, agents and salesmen, and enough electrical assistance to keep full and complete records and books of account, and, under the general

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direction of the Light Co., will attend to all correspondence and otherwise promptly and well dispose of all business that may arise under the provisions and requirements of this contract.

A list of certain existing agency contracts between the Light Co. and its agents, is hereto annexed, marked Exhibit "A," and the Isolated Co. hereby assumes, during the continuance of this agreement, the various obliga-
9494 tions imposed upon the Light Co. by the said contracts, including all compensation to agents therein provided for, and as further consideration therefor, it is agreed that the provisions of the twelfth section herein, giving the Isolated Co. one-quarter of certain percentages accruing to the Light Co., shall apply to all local companies formed by said agents and licensed by the Light Co. during the continuance of this agreement. The Light Co. will not alter any of the said agency contracts while this agreement lasts, without the Iso-
9495 lated Co.'s consent.

Such canvasses, surveys, determinations and estimates for central station plants, as the Isolated Co. may voluntarily make from time to time, shall be at its own expense, but the Isolated Co. shall also make them for the Light Co., whenever requested in writing by the Light Co. to do so, and in all such cases a reasonable percentage of profit shall be added to the actual cost of making them, to be paid by the Light Co., as compensation to the Isolated
9496 Co.

Fifth.—The Isolated Co. will keep full records and other data of every kind growing out of the transactions provided for in this agreement, and will accord to the Light Co., at all reasonable times, full opportunity to examine the same and to otherwise familiarize itself therewith, including free access to all books of account, records and correspondence, with full and

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free right to examine the same and make extracts therefrom, relating to the subject-matter of this agreement; and the Isolated Co. will at all times, both during the continuance of this agreement and thereafter, supply to the Light Co. any part or all of such specifications, data, drawings, estimates and electrical determinations, as it may demand, but at the expense of the Light Co.

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Seventh.—The Isolated Company shall make written monthly reports to the Light Co., while this agreement continues, setting forth, in such detail, form and manner as the Light Co. may from time to time direct, all transactions and contracts, under this agreement.

The territorial area intended to be covered by this agreement is the whole of the United States of America and the Dominion of Canada, save and except such parts of the United States as are already covered 9499
by certain agreements heretofore made by the Light Co., a full list of which is hereto annexed marked Exhibit "B," copies of which the Light Co. hereby agrees to furnish to the Isolated Co. on demand.

Eighth.—It is agreed that nothing herein contained shall alter, disturb or in any way affect, except as herein expressly provided for, the said certain agreement heretofore made between the Light Co. and the Isolated Co., dated April 26th, 1882, but 9500
that, except as specifically provided for in this instrument, the said agreement shall remain in full force and effect, notwithstanding the existence of this contract, just as if this agreement had never been made.

Ninth.—Whereas circumstances not now foreseen
may arise, which may make it desirable not only for the
Isolated Co. to sell and install Edison plants for
central station lighting, but also for the licensee com-
panies of the Light Co., or either of them, to
make such installations: it is, accordingly, agreed that
the license herein given to the Isolated Co., to
sell and install Edison plants for central station
9502 lighting, together with all the appurtenances thereto
belonging, is not an exclusive one, but that the Light
Co. reserves to itself the right to authorize its
licensee companies to make them; and it is further
agreed that in all such cases, the Isolated Co.
will, at the written request of the Light Co.,
and upon being paid the cost thereof together with
a reasonable profit thereon, supply any and all draw-
ings, determinations, plans, materials and other
things, that may be required.

Tenth.—No license or agreement to license by the
9503 Light Co., herein contained, shall be construed,
to refer to, or to embrace by implication or otherwise
any license or agreement to license under any letters
patent except such as the Light Co. may own
during the continuance of this agreement and license.
No grants, or licenses, or privileges shall be implied
from the licenses and privileges expressly granted in
and by this agreement to the Isolated Co. but
the rights and privileges of the Isolated Co. here-
under, shall be restricted to those expressly mentioned
9504 in this agreement.

Eleventh.—Whereas the Light Co. now owns
fifty-one one-hundredths of the capital stock of the
Isolated Co., and, under its said contract with
the Isolated Co., dated April 26th, 1882, is en-
titled to receive, without additional compensation, a

like proportion of all future increases of said capital,
which provision of the said agreement, it is agreed
this contract does not in any way alter or disturb;
and, whereas, the Light Co. consents, during the
continuance of this agreement, and as further and spec-
ial compensation to the Isolated Co., to mak
certain concessions touching dividends on its said
stock, in favor of the other stockholders, to wit, the
holders of the remaining forty-nine one-hundredths 9506
(which stock, for convenience of designation, is herein
called *cash stock*, as distinguished from the Light Co.'s
holdings, herein called *Light Co.'s stock*: it
is agreed as follows, that is to say:

1. All net earnings of the Isolated Co., appli-
cable to dividends, shall, during the continuance of
this agreement, be applied, first, to paying a dividend
of, or dividends aggregating not more than eight per
centum per annum on the said cash stock; second, to 9507
paying a like dividend, or like dividends, on the Light
Co.'s stock, aggregating not more than eight per
centum per annum; and, third, after the said divi-
dends aggregating eight per centum per annum on
both classes of stock shall have been paid, any surplus
shall be distributed among all the stockholders ac-
cording to holdings, including both the cash stock and
the Light Co.'s stock.

2. As to the said dividends, each year shall stand by 9508
itself, and no deficiency in any one year, whether as to
dividends on the cash stock or on the Light Co.'s
stock, shall be carried over to another year (except as
provided for in the twelfth section herein.)

3. Touching the existing profits and losses of the
business of the Isolated Co., as they stand at the

execution of this agreement, it is agreed that no separate estimate and allowance of them shall be made, but that, whatever they may be, they shall, as regards all questions of dividends herein provided for, be considered as forming a part of the general current business covered by this agreement, just as if they were the outcome of transactions made during the continuance of this agreement. But upon the termination of this agreement,
9510 the question what net profits, if any, there then are applicable to the said dividends provided for herein, that is to say the question whether there are any profits, and if so, how much, to be apportioned between the Light Co.'s stock and the cash stock in the manner provided for in paragraph number one of this section, shall be determined by arbitration, as follows, to wit: an arbitrator shall be appointed by the holders of the cash stock, at a meeting of such shareholders, to be specially called for that purpose by the Isolated Co., on not
9511 less than six days' written or printed notice stating the object of the meeting, and mailed to every stockholder except the Light Co., whose name and address may then appear on the books of the Isolated Co.; a second arbitrator shall be appointed by the Light Co., and if these two cannot agree, they shall select a third, and the decision of said two arbitrators, or if a third be called in, the decision of a majority, touching the whole subject matter, covered by said question, including not only the amount of dividend to be declared
9512 from said net profits, if any, but also when to be declared and paid, shall be final and binding upon both the Light Co. and all the holders of the said cash stock. If the said arbitrators are not able at once and without delay to properly determine the value of assets or other data entering into the subject-matter covered by the said question, referred to above, and may, for that or other good reason, desire to delay the making of their report, it is agreed that they may take such

length of time, within which to make and render their decision as to them, or a majority of them, may seem best. At the said meeting of the cash stockholders to select their arbitrator, as aforesaid, they may vote either in person or by proxy, and a majority of the shares of stock thus voted on shall decide.

4. During the continuance of this agreement, the Light Co. shall not sell, or otherwise transfer its 9514
said holding of fifty-one one-hundredths of the stock of the Isolated Co. or any part thereof without the written consent of the Isolated Co.

Twelfth—In order to stimulate the Isolated Co. to seek and push the business of exploiting central station companies, and more especially to encourage it to do so in localities where ultimate success may seem doubtful, the Light Co. hereby agrees that whenever, during the continuance of this contract, any 9515
licensee company shall be formed pursuant to this contract, and a percentage of its original capital, whether in stock or cash, or both, be paid to the Light Co. for a license, one quarter of the percentage of such original capitalization thus paid to the Light Co., shall be immediately paid by the Light Co. to the Isolated Co.; and if in any case the said original capitalization of any such company be increased during the continuance of this contract, the same proportion of the percentage of such increase 9516
accruing to the Light Co. shall also be paid to the Isolated Co.; but the Light Co. shall not make any such payment of said one-quarter, where the capital is increased and the Light Co.'s percentage is paid to it after the termination of this contract. The said one-quarter share of stock in any licensee company thus received by the Isolated Co. for its own benefit, shall remain in its treasury till sold,

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and when sold the proceeds shall be applied as follows,
to wit: first, to equalizing all back dividends between
the cash stock and the Light Co.'s stock, which
are provided for in the eleventh section herein: and
second, any balance remaining after all of such back
dividends shall have been equalized between the said
two companies, shall be carried to the general profit
and loss account of the Isolated Co.

9518 *Thirteenth.*—Regarding the Isolated Co.'s priv-
ilege to manufacture any and all patented devices
of the Light Co., except lamps, required for its
business, provided for in said contract between the
Light Co. and the Isolated Co., dated April
26th, 1882, and more especially in the fourth
section of the said contract, it is agreed, in considera-
tion of the advantages accruing to the Isolated Co.
9519 under and pursuant to the provisions of certain
contracts heretofore made between the Light Co.
and certain manufacturing establishments and
the stockholders therein, a complete list of which is
hereto annexed marked Exhibit "C" (copies thereof
having heretofore been furnished the Isolated Co.)
that said contracts, each and all of them, are hereby
approved and accepted by the Isolated Co. as
binding upon it while the said several contracts continue
to exist, touching all questions relating to the Isolated
9520 Co.'s privilege of manufacture mentioned above;
and that the Isolated Co. will not manufacture
any of the devices covered by said contracts, severally,
while the several contracts covering such several de-
vices last, but whenever any of said contracts termi-
nate, the Isolated Co shall then be free to man-
ufacture, pursuant to the provisions of its said con-
tract dated April 26th, 1882, and not otherwise, the
particular devices covered by said contract. But the
Light Co. hereby agrees to use its best endeav-

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ors always to enforce the provisions of the said con-
tracts, and more especially to do so at any and all
times, whether this agreement shall then be in force
or not, upon the written request of the Isolated Co.,
and if any controversy ever arises between the
Light Co. and the Isolated Co. as to whether
said provisions are enforced, or ought to be,
or can be, it shall be left to arbitration in the same
manner as provided for in the eleventh section hereof. 9522

It is further agreed that during the continuance of
this agreement the Light Co. will not terminate
or alter the said agreements mentioned in Exhibit C,
or any of them, without the written consent of the Iso-
lated Co.

Fourteenth.—Whereas radical and important changes
in conducting the business of the Light Co. and
Isolated Co. are imposed by this contract, where-
in all possible contingencies may not now be foreseen, 9523
but which, although contrary to the present expecta-
tion, it may be of interest to either or both of said
companies to terminate at an early day, thereby mak-
ing it proper that this agreement, at least in the first
instance, should be made for only a very limited peri-
od, terminable at the option of either party at the ex-
piration of that time; therefore, it is agreed, either
party may terminate this agreement after one year
from the date thereof, but not before, upon giving at
least six months' prior written notice to the other 9524
party.

In Witness Whereof the parties here-
to have severally caused these pres-
ents to be executed by their officers
thereto expressly authorized, and their
respective corporate seals to be affixed
and attested, at the City of New York,
the day and year first above written.

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EXHIBIT A.

A List of All Existing Agency Contracts between The Light Co. and its Several Agents.

	Name of Agent.	Date of Contract.	Territory.
	Western Edison Light Co.	July 1, 1882.	The States of Illinois, Wisconsin and Iowa.
	Geo. S. Ladd.	July 15, 1882.	States of California and Nevada.
9526	E. A. Mexia.	Aug. 18, 1882,	The Republic of Mexico.
	P. B. Shaw.	April 7, 1883.	The State of Pennsylvania, except the following cities: Philadelphia, Harrisburgh, Reading, Erie and Pittsburg.
	Spencer Borden.	April 10, 1883.	New England, except Connecticut west of the Connecticut River.
	Chas. T. Hughes.	June 4, 1883.	The following Counties in New York: Otsego, Delaware, Schoharie, Greene, Dutchess, Columbia, Putnam, Rockland and Westchester.
9527	H. A. Clark.	June 12, 1883.	Cities of Erie, Harrisburgh and Pittsburgh, Pa., District of Columbia and State of Maryland.
	Ohio Edison Electric Installation Co.	June 13, 1883.	State of Ohio.
	T. P. Wilson.	July 19, 1883.	State of Minnesota.
	C. A. Benton.	Sep. 1, 1883.	All that part of the State of New York lying north and east of, and excluding the Counties of Columbia, Albany, Delaware, Broome, Cortland, Onondaga, Cayuga and Wayne, excepting the County of Oneida and the City of Albany.
9528	John Hoskin.	Sep. 28, 1883.	City of Philadelphia, Pa.
	John R. Markle.	Nov. 15, 1883.	State of Michigan.
	W. P. Hix.	Jan. 4, 1884.	General Contract.
	T. A. Edison.	Jan. 26, 1884.	Republic of Chili, S. A.
	A. S. Kissell.	Feb. 27, 1884.	General contract, embracing the States of Indiana, Missouri, Texas and Tennessee.
	Wm. D. Tyler.	May 1, 1884.	State of Oregon and Washington Territory.
	A. Pizzini.	May 1, 1884.	City of Richmond, Va.
	Zachry & Thornton.	May 9, 1884.	City of Atlanta, Ga.
	C. T. Hughes and W. S. Howell.	June 9, 1884.	City of New Brunswick, N. J.

Note.—Some of the above contracts have expired, but inasmuch as no formal annulment of them has yet been made, they are included in the list in order to make it complete. For the same reason, certain contracts, notably the Western Edison and the Ladd, are included, although they are not, strictly speaking, agency contracts.

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EXHIBIT B.

Name of Licensee.	Location.	Date of Contract.	Date of License.	Capital.
Edison Electric Illuminating Company of New York	N. Y. City.	Mch. 23, 1881.		$1,000,000
Edison Co. for Isolated Lighting	N. Y. City.	Apl. 26, 1882.		1,000,000
Western Edison Light Co.	Chicago, Ills.	July 31, 1882.		160,000
Appleton Edison Light Co. (Limited)	Appleton, Wis.	Jan'y 16, 1883.		100,000
Geo. S. Ladd	San Francisco, Cal.	July 15, 1882.		
E. E. Ill'g Co. of Lawrence	Lawrence, Mass.	Aug. 31, 1883.		30,000
" " Brockton	Brockton, Mass.			100,000
" " Shamokin	Shamokin, Pa.	May 4, 1883.		37,000
" " Sunbury	Sunbury, Pa.	May 8, 1883.		20,000
" " Fall River	Fall River, Mass.	Sep. 20, 1883.	Sep. 20, 1883.	90,000
" " Newburgh	Newburgh, N. Y.	Oct. 29, 1883.	Oct. 29, 1883.	60,000
Tiffin Edison Electric Ill'g Co.	Tiffin, O.	Oct. 25, 1883.	Oct. 25, 1883.	40,000
E. E. Ill'g Co. of Hazleton	Hazleton, Pa.	Oct. 31, 1883.		25,000
" " Williamsport	Williamsport, Pa.	Nov. 24, 1883.		100,000
" " Middletown	Middletown, Ohio.	Nov. 28, 1883.		20,000
Piqua Edison Electric Ill'g Co.	Piqua, O.	Jan. 29, 1884.	Mch. 10, 1884.	40,000
E. E. Ill'g Co., Bellefonte	Bellefonte, Pa.	Nov. 17, 1883.		16,000
" " Circleville	Circleville, O.	Mch. 28, 1884.	Mch. 25, 1884.	30,000
" " Cumberland	Cumberland, Md.			
" " Ashland	Ashland, Pa.	May 27, 1884.		
The Ohio Edison Electric Installation Co.	Cincinnati, Ohio.	June 13, 1883.		250,000
E. E. Ill'g Co. of Knoxville	Knoxville, Tenn.			40,000
DesMoines Edison Light Co.	DesMoines, Ia.	July 30, 1884.	July 30, 1884.	80,000
Roselle (No license has been issued to any company on account of this station, as it belongs to the Light Co. and Isolated Co. jointly.)	Roselle, N. J.			
E. E. Ill'g Co. of Mount Carmel (Licensed by Edison Co. for Isolated Lighting, it being a non-gas town.)	Mt. Carmel, Pa.	Jan'y 15, 1884.		

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EXHIBIT C.

LIST OF CONTRACTS MADE BETWEEN LIGHT CO. AND CERTAIN MANUFACTURING ESTABLISHMENTS AND THE STOCKHOLDERS THEREIN.

Contract between the Edison Electric Light Co. and Bergmann & Co.

9534 Contract between the Edison Electric Light Co. and individual stockholders of Bergmann & Co.

Contract between the Edison Electric Light Co. and the Edison Machine Works.

Contract between the Edison Electric Light Co. and individual stockholders of the Edison Machine Works.

Contract between the Edison Electric Light Co. and the Electric Tube Co.

Contract between the Edison Electric Light Co. and
9535 individual stockholders of the Electric Tube Co.

NOTE.—All the above contracts are dated September 1st, 1884.

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Defendant's Exhibit, Agreement Between Sawyer and Man, March 19, 1878.

Received for record April 4, 1882, and recorded in Liber A 28, page 117 of Transfer of Patents.

In testimony whereof I have caused the seal of the Patent Office to be hereunto affixed.

E. M. MARBLE, 9538
Commissioner.

Memorandum of agreement between William E. Sawyer, of the first part, and Albon Man, of the second part.

The party of the first part has made certain inventions, and obtained patents having reference to the distribution, regulation, production and use of electricity, and especially its use for electric lighting, and the forms of burners or lamps, and the media menstrum 9539
or bath in which light is produced to prevent oxidation, combustion and transference, and is engaged in experiments in these matters to render the same practical, has agreed to sell and convey to the party of the second part fifty-five one hundredths parts of all his said inventions and patents and discoveries of and concerning the use, distribution, regulation and production of electric currents, especially as relating to electric lighting, and all other matters and things affecting the same for the sum of $2,500, to be paid to the party of the 9540
second part within two months, as he may require it; he to procure all necessary patents at his own expense; Man to have ten days to complete his arrangements for associates with him, and $150 to be paid to Sawyer meantime for experiments under the agreement with and between these parties, dated February 15, 1878. When all is completed and signed Sawyer to go

9541 on with his experiments and take out his patents, and whenever Man and his associates are ready, a joint stock company to be formed, and all inventions and patents to be assigned to it and the stock to go 55-100 to Man and his associates and 45-100 to Sawyer.

This has no reference to Sawyer's patent electric engine or telegraphs, but does to and includes inventions and discoveries made in aid of electric lighting or other uses of electricity under the experiments above referred to.

9542 Dated March 19, 1878.

(Signed) W. E. SAWYER.
ALBON MAN.

Witness:
WM. HALLIE.

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Defendant's Exhibit Agreement between Sawyer and Man, May 11. 1878.

Received for record April 4, 1882, and recorded in Liber A 28, page 118, of Transfers of Patents.

In testimony whereof I have caused the seal of the Patent Office to be hereunto affixed.

E. M. MARBLE,
Commissioner.

NEW YORK, May 11, 1878. 9546

Whereas, on the 19th day of March, 1878, an agreement was made between the parties hereto, to which reference for particulars is hereby made; and

Whereas, contrary to the expectations of the parties, the plans originally proposed by the party of the first part did not prove practically successful, and the party of the second part then came in and made certain suggestions which were generally adopted, and has from time to time made suggestions in relation to the subject-matters of said agreement which have been adopted, 9547
and through which suggestions it is believed that success has been achieved, and

Whereas, the parties hereto are unable to distinguish which of them is the author of different parts of the inventions hereinafter referred to;

Therefore, it is hereby agreed by and between WILLIAM EDWARD SAWYER, party of the first part, and ALBON MAN, party of the second part, in modification of their previous agreement, as follows:

That instead of the Letters Patent being taken out 9548
in the name of the party of the first part solely, it shall be taken out in the names of both parties hereto, and the interests to be held by said parties in the same shall be, to the party of the first part 45-100, and to the party of the second part 55-100. In other respects, the agreement of March 18, 1878, referred to, shall stand, except that the party of the second part is considered to have accepted and does hereby accept the

9549 inventions mentioned in said agreement, and those inventions jointly made by himself and the party of the first part, to wit, 55-100 of the same, for the sum of $2,500, of which sum the party of the first part hereby acknowledges the receipt of $1,372.75, the balance, viz., $1,127.25, to be paid to the party of the first part, from time to time, as he may call for the same, to cover the expenses of letters patent about to be applied for in the United States, and to meet his personal expenses.

Certain inventions covered by Letters Patent of the
9550 United States, as follows: "Electric Engineering and
Lighting Apparatus and System," No. 194,111, dated Aug. 14, 1877; "Electric Candles," No. 194,500, dated Aug. 21, 1877; "Electric Apparatus," No. 194,563, dated Aug. 28, 1877; and "Electric Engineering and Lighting System," No. 196,834, dated Nov. 6, 1877; having been assigned to the extent of 3-5ths thereof to James Flanagan, and the party of the first part; claiming that he has the right, as he stated at the time of making the agreement of March 19th, to withdraw the same
9551 from the said Flanagan and obtain a reassignment
thereof within one year from about the 15th of February last, the party of the first part hereby agrees to assign to the party of the second part the remaining 2-5ths of said patents which he now holds, and within the time limited by this agreement with said Flanagan, to redeem from him the other 3-5ths, and assign the same to the company to be formed by the party of the second part, for the purpose of holding and operating under all the patents obtained, and to be obtained, which are referred to in this agreement and in the agreement
9552 of March 19th, 1878.

The inventions herein referred to, which are to be jointly patented by the parties herein, are to be considered as though they had been the sole inventions of the party of the first part under the agreement of March 19th, 1878, and a joint stock company is to be

formed, and all the patents obtained, and to be obtained, as proposed in said agreement, are to be as- 9553
signed to the said company when formed, including the 2-5ths interest in the four Flanagan patents hereinbefore enumerated and agreed to be assigned to the party of the second part, and the stock of the company is to be distributed as set forth in said agreement.

The joint inventions of the parties hereto being at present as follows: Electric Lamp; Regulator for Elec-
tric Lights, Electric Lighting System, and other appa- 9554
ratus and inventions now under consideration; it is hereby agreed that the party of the first par tshall devote his time and attention exclusively to perfecting the same, and to the procurement of United States Letters Patent upon the same; the expenses of procuring said patents to be borne by him; but after the proposed company is formed, which shall be with all reasonable dispatch after the joint patent on the lamp is obtained, the company is to bear the expense of all
new patents and new inventions. 9555

And the said Sawyer hereby agreees to assign to said company any rights remaining to him in any of his telegraphic inventions, in so far as their application to the purposes of electric lighting is concerned.

W. E. SAWYER.
ALBON MAN.

Witness:

P. M. STRATTON.

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Defendant's Exhibit No. 30.

UNITED STATES PATENT OFFICE.

SAWYER AND MAN
v.
9558 EDISON.
} Electric Lamps.

Appeal from the Examiners-in-Chief.

Application of Sawyer and Man, filed Jan. 9, 1880.

Application of T. A. Edison filed Dec. 11, 1879.

Mr. A. BROADNAX for Sawyer and Man.
Messrs. L. HILL and H. R. GARDEN of Counsel.
9559 Mr. G. W. DYER for Edison.
Hon. ROSCOE CONKLING of Counsel.

The invention in controversy is defined as follows:

"The incandescent conductor for an electric lamp "formed of carbonized paper."

Priority of invention was awarded to Edison by the Examiners-in-Chief, and from their decision appeal is taken to the Commissioner in person by Sawyer and
9560 Man, alleging that said decision is erroneous both in fact and law.

Before proceding to a consideration of the question of priority of invention, it is necessary that certain other questions should be determined which were referred to by the Examiners-in-Chief in their decision, and urged by counsel for Edison in their arguments at the hearing.

They are as follows:

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First.—Are the inventions claimed by the respective parties substantially the same?

Second.—Are Sawyer and Man joint inventors of the subject matter in controversy?

A negative answer to either of those questions would necessarily require a dissolution of the interference. If the inventions made and claimed by these parties are not substantially the same invention, a de- 9562
cision in favor of either would be of no effect; and if Sawyer and Man are not joint inventors of the subject-matter claimed by them, their application was improperly filed, and there is in fact but one applicant properly before the office claiming the invention.

The application of the respective parties disclose the invention—one specifically and the other in connection with carbons formed of other substances. The interference, therefore, was properly declared, because an interference exists where two applicants are claim- 9563
ing substantially the same invention, and where an applicant claims an invention described and claimed in an unexpired patent. For a proper determination of the first question, it will be necessary to examine the record of the case, or at least so much of it as may be necessary to ascertain the inventions claimed by the respective parties. Edison in his application describes his carbon and its manufacture as follows:

"I make use of paper of the desired thick- 9564
"ness as free as possible from foreign sub-
"stances or adulterations, and for this purpose,
"I prefer and use Bristol board. With suita-
"ble instruments, such as a punch and die, I
"cut out a narrow strip of this paper, prefera-
"bly in the form of an elliptical bow or an arc
"of a circle, the ends of the strip being by
"preference wider than the other portions.

"A number of these pieces of paper are "laid flat-wise in the bottom of a mold, pre- "ferrably of wrought iron, and there is laid on "them a light weight in the form of a flat piece "of gas retort carbon or other device that will "not be distorted by the heat. If several of "these are laid one on the other in the "mold, a piece of tissue paper is interposed "between each one and the next.

9566 "A cover is used to close the mold, and the "mold is raised very gradually to a tempera- "ture of about six hundred degrees Fahr. This "allows the volatile portions of the paper to "pass away, and at the same time the mold "retains the paper in its proper shape and "the paper is prevented from curling up or "becoming distorted, as it would be likely to "do if the heat were applied suddenly or the "light weight dispensed with.

9567 "The mold is now placed in a furnace and "heated almost to a white heat and then "removed and allowed to cool gradually. "The carbon filaments will be found "to be smaller than the card board "blanks, and to be sufficiently strong "and flexible for handling. The ends of "the carbon are to be secured to the me- "tallic conductors in any convenient manner

"The carbon filaments prepared as afore- "said are very uniform in their resistance to

9568 "the electric current, and I make them thin "and of a sufficient length to offer a great re- "sistance to the passage of the current."

Sawyer and Man do not describe in their specifica- tion the process of making their paper carbon, but refer to a paper carbon, and in their fourth clause spe-

cifically claim it. Resort must, therefore, be had to the testimony taken in their behalf to show what their paper carbon is.

Albon Man on this point testified as follows:

"4 Q. State, if you please, how you made "the carbons, and of what form they were "after they were made?

"A. We made the carbons in two different 9570 "ways—or three. The first were carbonized "by the heat of the electric current the paper "being fastened between two conductors and "filled with plumbago in some cases, and in "some cases with mineral salts. The first ex- "periment was in the open air, subsequent "experiments in a reservoir of hydro-carbon "gas and probably, although not positively, "in a reservoir of hydrogen, also in a reservoir "of nitrogen, the reservoir being of glass and 9571 "sealed up, the metallic conductors to which "the paper was affixed passing through to the "interior of the reservoir in which the gases "were contained. Another method of manu- "facture was to place the paper in an iron "box in powdered gas carbon, close the box "and heat the whole in fire. The form of "the papers were various; some of them sim- "ple straight strips of paper, some of them "were strips of paper cut into an arch form 9572 "and inserted edgewise between the metal "conductors: some of them were bent in an "arch form and inserted flatwise between the "conductors. 'A' in drawing Figs. 1, 2 and "3 of the application for patent, represents "the form where the paper was cut into an "arch. Where the paper was straight with- "out being cut into arch form it was some-

9573 " times tied to the conductors with wire and " sometimes inserted in slits in the top of the " conductors and packed with powdered car- " bon to make connection with the conductor, " sometimes fastened between clamps formed " by binding screws passing through the heads " of the metal conductors." (Sawyer and Man's Record, pages 3 and 4.)

9574 " 12 Q. Please to describe now what, if any, " preparation you gave to the paper before " carbonizing it?

" A. Before carbonizing the first time we " filled the paper sometimes with a solution of " white loaf sugar, and sometimes with Cana- " da balsam, and after carbonizing the first " time, we soaked the carbon produced in the " solution of loaf sugar sometimes, and some-
9575 " times in Canada balsam and recarbonized " it; repeating operation several times in " some instances; in other cases we did not " treat the paper at all before carbonization; " this was in the preparation of the carbon " which was made in the furnaces, in the " preparation of the carbon made with the " electric current in order to make the paper " a conductor we coated it with graphite or " plumbago, and sometimes soaked it in solu-
9576 " tions of different metallic salts and dried it; " the latter process did not seem to work well; " paper filled with plumbago worked the best." (Ibid, page 55.)

" 17 Q. Please to state what further treat- " ment you gave the carbon before you put it " into the lamp?

" A. After it was placed between the metal " conductors, we put it in a sealed reservoir " of hydro-carbon gas or a reservoir through

" which hydro-carbon gas was passing; the " reservoir being of glass so that we could ob- " serve what was going on; we then turned on " a current of electricity gradually and heated " up the carbon while it was in the bath, " first to about a good white heat, and after " wards to high incandescence, continuing it " so long as to perfect the carbon, by rendering
" it uniform in resistance by deposit of carbon 9578
" from the gas, which went on under these con- " ditions. At the point or points of highest " resistance first, and subsequently over the " whole carbon." (Ibid, page 7.) 9577

Other witnesses called in behalf of Sawyer and Man testified on this point substantially to the same effect.

Edison uses his carbon in a glass bulb from which the air has been exhausted by a pump to the millionth
of an atmosphere. Sawyer and Man use their carbon 9579
in a similar bulb from which the air has been expelled by the introduction of nitrogen or hydrogen gas. Both carbons are used in substantially the same way and for the same purpose. It is urged in behalf of Edison that because Sawyer and Man treat the paper before it is carbonized, and subject the carbon after it has been formed to the treatment of hydro-carbon gas, as stated by Mr. Man, it is no longer
an incandescent conductor for an electric lamp formed 9580
of carbonized paper, but a compound conductor, and that the paper carbon is simply a frame work upon which a coating of carbon is deposited, and that the original character of the paper carbon is entirely changed.

On behalf of Sawyer and Man it is urged that notwithstanding the treatment to which the paper and carbon are subjected, the carbon is still one formed of carbonized paper. The only witness who testified un-

9581 derstandingly as to the effect which the deposit of car-
bon had upon the paper carbon, was Mr. Batchelor, a
witness called in behalf of Edison.

"158 x-Q. What experience, if any, have
"you had in treating paper carbon electri-
"cally in the presence of hydro-carbon gas?
"A. I have had considerable experience
9582 "in treating carbonized paper used as an in-
"candescent conductor in hydro-carbon
"vapor in connection with the paper carbon
"loops of Edison's electric lamp.
"159 x-Q. What effect does such treatment
"have upon the paper carbon burner?
"A. It deposits carbon from the hydro-
"carbon on the surface of the incandescent
"conductor.
"160 x-Q. Doesn't it fill up the interstices
9583 "and consolidate the carbon, making it finer
"and more compact?
"A. It probably does fill up the little inter-
"stices on the surface, but I do not think it
"makes the paper carbon any more compact.
"It adds to that by coating on the surface. I
"have frequently broken these conductors
"that have been treated in the vapor of the
"hydro-carbon, and, under a powerful micro-
"scope, have found that the fracture of the
9584 "paper carbon showed no greater density,
"and the deposited carbon sticking to it in
"the shape of small needles stuck endwise on
"it." (Edison's Record, pages 179 and 180.)

Other witnesses testify as to the manner in which
the conductor performs its function after being treated
in a hydro-carbon vapor, but not as to the effect
which such treatment has upon the paper carbon.

9585 From Mr. Batchelor's statement it will be seen that
the paper carbon is not affected by such treatment ex-
cept by the coating of carbon which it receives. In all
other respects it remains the same.

The invention, as claimed, is broadly to the incan-
descent conductor for an electric lamp, formed of car-
bonized paper. The claim is without limitation, and
was intended to cover, I think, any kind of a conductor
for an electric lamp formed of carbonized paper. 9586

Can it be truthfully said that the conductor made
and claimed by Sawyer and Man is not a paper car-
bon? Before its treatment in hydro-carbon vapor it
certainly is. Does that treatment change its entire
character? Is the desk at which I sit not a wooden
desk, beceuse covered with a coat of varnish? Is the
paper on which I write not paper, because sizing was
used in the manufacture to give it body and finish?
Are the doors which lead into this room not wooden
doors, because there is a coating of paint on them? 9587
The desk and the doors are undoubtedly improved by
the coatings of varnish and paint, because made more
durable in any atmosphere, and under any conditions,
but they are used in the same manner as if the coat-
ings were not on them and are known by the same
names.

So with Sawyer and Man's carbon; it is undoubtedly
changed somewhat by the coating of carbon deposited
thereon; but it is neverthelesss, I think, a paper car-
bon. The carbon when prepared by either of the 9588
parties in the manner described by them become in-
candescent conductors when placed in a lamp from
which the oxygen has been removed, either by ex-
haustion by a pump, or by expulsion by hydrogen
or nitrogen gas. Neither will operate unless
the oxygen is removed, and both will when it is. In
other words, each of the carbons become an incandes-

cent conductor under substantially the same conditions. They are, therefore; substantially the same, and must be so held. If counsel for Edison considered them otherwise, they should have moved a dissolution of the interference after the testimony was originally concluded, and not a re-opening of the case for the taking of further testimony.

At all events such motion should have been made before the case was fully submitted on the merits a
9590 second time to the Examiner of Interferences for decision on the question of priority of invention. The idea that the invention claimed by Sawyer and Man, does not fall within the issue was clearly an after thought conceived after the decision by the Examiner of Interferences on the question of priority in favor of Sawyer and Man.

In relation to the second question Sawyer testifies
9591 that he first suggested the making of carbon from paper. Man testifies that he does not know whether Sawyer or himself first suggested it. The first experiment following the suggestion, by whomsoever made, was an attempt to pass an electric current through a piece of paper which had been marked with a lead pencil. That experiment was not attended with much success, but subsequently it was found that by rubbing the paper with plumbago the current could be passed through and the paper carbonized. Carbonization of
9592 paper, however, was not new, and hence, whether it was carbonized in that or any other way, so far as this issue is concerned, is immaterial.

After the experiments of Sawyer and Man to carbonize paper by electric currents, the plan was adopted and subsequently followed, which is set forth in the testimony of Mr. Man above quoted.

In their efforts to carbonize paper, the testimony of Man and Sawyer, as well as other witnesses, shows that both the parties were engaged in devising ways

and means to secure a perfect carbon from paper, very likely each of them made suggestions which were adopted; they were working together for a common end and object, viz: The carbonization of paper, which was finally accomplished in the manner described by Mr. Man.

Where two or more parties thus unite their efforts to accomplish a particular object, and by such efforts that object is secured, I think it must be held that the product obtained, if any is obtained, is the joint product of both. There is no doubt in my mind that Sawyer and Man should be considered joint inventors of the incandescent conductor made by them. 9594

The case, therefore, recurs on the question of priority of invention.

From the testimony it appears that Edison, in 1876, made certain experiments in the carbonization of paper, and in determining the resistance of such carbons.

The history of Edison's experiments in electric lighting by incandescent paper carbon is fully and succinctly stated by Mr. Batchelor, a witness called on his behalf, who testified that he had had general charge of all of Edison's experiments during the last eight or nine years. His testimony is as follows: 9595

> "37 Q. Please to give a summary, in a con-
> "nected way, mentioning dates, as far as
> "possible, of the progress of the invention of
> "incandescent conductors for electric lights 9596
> "made of carbonized paper, from the begin-
> "ning up to the completion of the commercial
> "lamp?
>
> "A. The history of electric lighting by in-
> "candescence with paper carbon by Mr. Edi-
> "son, so far as I know it, is as follows: In
> "the summer of 1877, he used strips of paper
> "carbonized as an incandescent conductor

"*in vacuo*, and the lamp in which they were
"used is now in evidence, and marked 'Ex-
"hibit Edison's First Incandescent Lamp.'
"I should have said here that I remember
"Edison, within a day or two previous to this
"lamp being made, using carbonized paper
"as an incandescent conductor between two
"electrodes of a battery, but in the open air.
9598 "The next experiment, or series of experi-
"ments, that I call to mind are the ones which
"I have before spoken of as being made in
"August and September, 1878. At this time
"my whole time and attention began to be
"devoted to development of his system of in-
"candescent electric lighting. These paper
"carbons were made by coating thin papers
"with lamp-black and tar and rolling up tight-
"ly into a rod, drying and carbonizing the
"same in a suitable furnace. Some of these
9599 "paper carbons were put in between the two
"electrodes in an electric circuit, and raised
"to incandescence in a vacuum. At this
"time carbons made of paper were not the
"only things that we tried as incandescent
"conductors in a vacuum. We made experi-
"ments with hard carbons, wood carbons and
"some metal, such as platinum, nickel and
"iron. It had early been decided by Mr.
"Edison that the requisite material for his
"incandescent lamp should have a great re-
9600 "sistance, combined with the least possible
"surface, and I remember well that at this
"time and previous, we used to expect that
"we should be able to get a substance for an
"incandescent conductor that would give us
"at least 500 ohms resistance. The result of
"this latter series of experiments in vacuo

"had shown us that in order to get a high
"resistance lamp from carbon in any form it
"would have to be cut in an exceedingly fine
"filament. The paper carbons which we tried
"were larger than we should have to use if
"we wanted a higher resistance. With the
"vacuum we then got, and which we consid-
"ered at that time to be good, the carbons
"lasted at the most from ten to fifteen min- 9602
"utes in a state of incandescence. The ex-
"periments on platinum led us to hope that
"it might be easier to get a high resistance
"from that metal than from carbon. From
"the date of the finishing of these experi-
"ments, which, I believe, was toward the
"latter part of October, 1878, Mr. Edison
"turned his attention to lamps in which the
"incandescent conductors were formed of
"metal and alloys of metal. During the last 9603
"part of the year '78, and up to October, 1879,
"I made, at Mr. Edison's request, a very large
"number of lamps having platinum and pla-
"tinum-iridium composing the incandescent
"conductor. A great many of these lamps had
"their conductors coated with insulating mate-
"rial in order to be able to wind them up close
"and get them into as small a space as pos-
"sible, in order to offer the least radiating sur-
"face. Mr Edison very frequently sat down 9604
"at my table and worked for hours helping
"me on these experiments. Our conversation
"frequently was directed to getting the high-
"est resistence in the least possible space. I
"remember once or twice during these con-
"versations, early in 1879, he remarked how
"easy it would be to get this resistance if
"carbon were only stable. During that time

9605 "I was experimenting on these lamps he had "been very busy experimenting to perfect the "different apparatus composing his electric "lighting system as a whole. I had also "worked on these matters, but as our lamp "was an exceedingly difficult job the majority "of my time, both night and day, with the "exception of a week or two in which I de-
9606 "voted some time to telephones, was spent on "the lamp. He had succeeded in making a "more perfect dynamo machine. In testing "the lamps with platinum conductors he had "been continually improving the apparatus "for exhausting the globes. In October, 1879, "when he had got a very perfect vacuum for "his lamp, he suggested the use again of car- "bonized paper as a conductor, and accord-
9607 "ingly he had me cut a fine filament of paper "which we carbonized and put in a globe. "This filament, I believe, was cut straight "from paper and bent round previous to put- "ting in the carbonizing chamber. I do not "remember what we did with this lamp after- "ward. But within a day or so of that I cut "a loop from paper similar in shape to the one "now in Edison's Commercial Incandescent El- "ectric Lamp. At the same time that these were
9608 "being tried I also made lamps of loops of "carbonized thread, carbonized flax, fine fila- "ments of lampblack and tar rolled up and "baked, and also threads which had been "treated with lampblack and tar previous to "carbonization. All these things we used a- "bout the same time as incandescent conduc- "tors in electric lamps, the most satisfactory "at the time being the carbonized paper loop

9609 "which I had cut by hand. We immediately "after this made a steel mold in which these "loops could be cut quickly, and after a few "experiments in the carbonization of them, "in order to get their resistance as near as "possible alike after carbonization, we made "a number of the filaments and used them at "an exhibition in Mr. Edison's house, about "the second or third of December, 1879. 9610
"When the first lamp was made, which had a "fine filamentary carbonized paper conductor "from which the light was given, which was "about October 22, 1879, then I believe "we had a system of electric lighting that was "complete and could compete with gas, and "we proceeded as expeditiously as possible to "exhibit it as such." (Edison's Record, p. 153.)

Mr. Edison testifies to his experiments in the carbon- 9611
ization of paper in 1876, to his experiments in 1877, with the lamp known as Edison's First Incandescent Lamp, to his experiments in 1878, when paper carbons were laid aside, and to his later experiments in 1879, in substance the same as Mr. Batchelor. On direct examination he was asked (Edison's Record, p. 12):

"24 Q. When did you produce electric "lamps with incandescent paper carbon con- "ductors in vacuum bulbs hermetically closed, "so as to be a commercially complete lamp, 9612
"capable of entering into competition with "gas light?

"A. I made such a lamp about October 22, "1879, which had the characteristics of high "resistance, small radiating surface, and suffi- "cient stability and economy to allow of com- "petition with gas."

On cross examination he testifies as follows:

"259 x-Q. State, if you please, when it was
"that you first reached the conviction that
"electric lighting could be successfully accom-
"plished by carbonized paper *in vacuo*?

"A. In September or October, 1879; that
"it could be accomplished by the use of car-
"bonized paper in high and stable vacuo,
9614 "which were the proper conditions. (Ibid,
p. 66).

"396 x-Q. When did you ascertain whether
"or not the conductor could be made small
"enough and burn under the proper con-
"ditions?

"A. I ascertained and obtained the proper
"conditions to allow of the conductor being
9615 "made small enough some time in October,
"1879. This was when it was placed in high
"vacuum." (Ibid, p. 140).

October, 1879, therefore, must be taken as the earliest date upon which Edison can be said to have had this invention. The invention in controversy is not simply a paper carbon, but an incandescent conductor for an electric lamp, resulting from the use of a paper carbon under certain conditions; the conditions under which he could use such a carbon for that purpose, according to his own statements, and those of the wit-
9616 nesses who had general supervision and management of all his experiments in electric lighting, but did not ascertain until that time.

Sawyer and Man, as appears from the testimony, commenced their experiments in electric lighting at No. 43 Centre street, in the City of New York, some time in February, 1878; there operations were continued at that place until the latter part of May, or first of June, of the same year. At about the latter date they removed to the corner of Centre and Howard streets

where their operations were continued until the latter part of September of that year; from thence they removed to No. 94 Walker Street, near the corner of Elm, where their operations were continued from that time untill the following May. Their experiments and demonstrations covered a period of about fifteen months.

Albon Man, one of the parties to this record, testifies as follows: 9618

"13 Q. State, if you please, when it was
"that you first used the carbon burners you
"have been describing in the sealed electric
"lamp?

"A. In March, 1878.

"14 Q. Can you state at what time in
"March, 1878?

"A. Between the 1st and 15th; I can't give
"the date."

"(Sawyer and Man's record, p. 6.) 9619

"18 Q. Please to state what part or parts
"of the invention and experiments were
"made, of which you have been testifying,
"previous to the 15th of March, 1878, and
"state what was done after that, and down to
"the months of October or November, 1878,
"in the order as near as you can, of its being
"done?

"A. We prepared the paper carbon, first 9620
"electrically, and subsequently by carboniza-
"tion in the furnace, in March, 1878, and
"from that time on to May continued our ex-
"periments with it, we treated it during this
"period in the hydro-carbon bath, improved
"it by soaking in sugar, etc., and re-carboni-
"zation. In September, 1878, we commenced
"the use of the oils, in connection with the
"electric current, in the preparation of car-

"bon. In October, 1878, we carbonized the
"complete paper circles or washers, and also
"straight pencils of paper, with better suc-
"cess than before, that is, having better ap-
"pliances for the work. I think the first
"lamps we exhibited with paper were in
"October, 1878; we had others before that,
"but did not exhibit them; we first had an
9622 "electric lamp fitted with a carbon burner,
"made of paper, in March, 1878." (Ibid,
p. 8.)

Referring to the experiments made by Sawyer and Man at their rooms on Centre street, Mr. Man testifies as follows:

"74-8 x-Q. What was the most satisfac-
"tory experiment you made at that place?
"A. With paper carbonized in the furnace.
"74-9 x-Q. How long did the carbonized
9623 "paper conductor last in this experiment?
"A. Until we took down the lamps, taking
"the carbon out practically uninjured. I
"can't say exactly how long. We were try-
"ing everything we could think of at that
"time. We ran the lamps for a time, and
"took them down to examine the carbon to
"see the effect, and to see if we had got the
"lamps sealed; we took them down often—
"daily, or every two or three days.
9624 "75 x-Q. What was the form of paper car-
"bon in this instance?
"A. That of a flat arch." (Ibid, pp. 18
and 19.)
"83 x-Q. What kind of paper was that
"carbon conductor made from?
"A. White blotting paper.
"84 x-Q. Single, or of several thicknesses?

"A. I should think several thicknesses
"pressed together.
"85 x-Q. Was that conductor coated with
"powdered carbon?
"A. No, sir; the paper was carbonized in
"box in furnace; was thicker after carboniza-
"tion than we wanted; was worked down
"with emery paper after being worked in
"shape with knife and filing. This refers to 9626
"paper shaped after carbonization. The
"burners shaped before carbonization were
"simply cut in shape with knife or scissors,
"and were ready for use after carbonization
"except rubbing them down on the emery
"paper.
"86 x-Q. Do you remember positively this
"carbon conductor was in a state of incan-
"descence for fifteen minutes?
"A. Yes, I should think for a couple of 9627
"hours at a time. (Ibid, page 20)."
"49 x-Q. How many lamps were you in
"the habit of running upon the same circuit?
"A. Largest number I think was eight.
"Usually ran but one.
"50 x-Q. How long did you ever run eight
"lights continuously at that shop?
"A. I should think probably a week.
"51 x-Q. Night and day right along?
"A. No, we ran none continuously for a 9628
"week; but ran them for several hours con-
"tinuously; we were troubled for power
"(Ibid, page 13)."
"113 R-d Q. State, if you recollect, how
"long you continued a paper carbonized
"burner in a state of incandescence at any
"one time?
"A. All day, and until late in the evening.
"This at the corner of Walker and Elm.

9629 "114 R-d Q. And what its condition when "you turned off the current?

"A. Same as when we put it on, except "possibly improved.

"115 R-d Q. When was that?

"A. That paticularr one I should say was "in the month of December, 1878.

9630 "116 R-d Q. And was that carbonized pa- "per burner made in the same way that those "were made at No. 43 Centre street.

"A. Yes, same as that in which some were "made at No. 43 Centre street. There were "other trials much before this, in October "but we only ran them during the day. (Ibid page 24.)

William H. Church, a witness sworn in behalf of Sawyer and Man, testifies as follows:

9631 "41 Q. Please to state when it was that you "first saw the paper carbons used in the "lamp—not experimentally, but in the lamp "as perfected?

"A. In September, 1878. (Ibid, page 31.)

"1 x-Q. I call your attention to the lamps "referred to in your 41st and 42d answers, "being the lamps you say you saw perfected "and in use in September, 1878, from that

9632 "time on during the winter. How many dif- "ferent lamps did you see at that time at the "places named?

"A. Quite a number; it would be difficult to "give the number of separate, distinct lamps; "sometimes the same lamp was taken down "and put up again and again; but for a guess "I should say 25 or 30; probably. But this "is a guess.

"2 x-Q. How many different lamps can

"you state from recollection that you saw 9633 "at that time at the places named?

"A. They put up one lot of lamps in which "there were six or eight of a kind. Then an- "another lot varying from that of about as "many more, or perhaps a dozen. Then still "another form of as many more, say a dozen. "Each of these lamps—some at least—were "taken down and refilled again, or perhaps 9634 "two or three times, to observe their work- "ing. There was still another kind I think "of, being four different lots. But the last "did not have a paper carbon, but a straight "pencil. Mr. Sawyer called it the feeder "lamp." (Ibid, pp. 31 and 32.)

"43 x-Q. How many lamps did you see in "circuit run by this 4-horse-power engine?

"A. I should think 6; might have been 7 9635 "or 8. Don't think more than 7 or 8. Have "watched 6 lights very often.

"44 x-Q. How long did you see these 6 lights "burning continuously at one time?

"A. Two hours and a half. Usually "watched them about an hour. Seen the cur- "rent turned in gradually from the light of a "very small taper up to a full incandescent "light—the best incandescent light by all "odds, I have ever seen. * * * * 9636

"46 x-Q. Do you know when this type of "lamp was produced?

"A. My wife was taken ill last November, "and died 11th of December (1878); it was "after the 16th of December I came to New "York. Then I think I saw this lamp for the "first time."

"48 x-Q. How many of these lamps did "you see in a circuit together?

9637 "A. About the same number, *i. e.*, about
"half a dozen, more or less. (Ibid, pp. 38and
"39.)

William Sawyer, a witness called on behalf of Sawyer and Man, testifies as follows:

"51 Q. State how long you saw any one of
"the carbons made of carbonized paper illu-
"minating continuously at the corner of
9638 "Walker and Elm streets, as near as you
"can recollect?

"A. My answer is about as before. We
"ran them from day to day.

"52 Q. Did you take occasion to examine
"them after they had been thus illuminated?

"A. Yes; some seemed as perfect as when
"they went in; others were fractured.

"53 Q. How many lamps did you have in
"circuit in Elm and Walker?

9639 "A. The highest number I think was eight."

"57 Q. State, if you know, how many of
"those lamps were filled with carbonized pa-
"per burners?

"A. Can't say positively, but think all were
"furnished with such burners.

"58 Q. Did you put carbonized paper burn-
"ers in the lamps yourself?

"A. Yes.

"59 Q. In Centre as well as Walker street?
9640 "Yes; I made them all." (Ibid, pp. 49 & 50)

William E. Sawyer, one of the parties to this record, testifies as follows:

"3 Q. The subject matter of this interference
"as given by the Patent Office is: the incan-
"descent conductor for an electric lamp form-
"ed of carbonized paper; please state whether

"or not you, in conjunction with Albon Man,
"have at any time made and used such a con-
"ductor?

"A. We have a great many times.

"4 Q. State, as near as you can recollect,
"when it was that you and Mr. Man made
"such a conductor?

"A. Almost immediately after we went to
"43 Centre street; should think about 6th 9642
"or 7th of March, 1878; might have been a
"little earlier or later."

"18 Q. State as near as you can recollect, how
"long the best of the carbon papers you made
"at 43 Centre would last in the lamp when
"raised to a temperature high enough to give
"a good, bright light, after having been treat-
"ed by the Sayer-Man process?

"A. Run at a power of about 25 candles 9643
"they would last from 5 to 100 hours; once in
"a while we would get a lamp so perfect in
"every respect that it would seem to undergo
"no change after a long use; but generally
"they would fracture in from 5 to 20 hours
"run at that temperature; the difference in
"the duration of the burners was due to both
"imperfections in the lamp and in the carbon;
"where the fracture alone occurs it must be
"due either to imperfection in the carbon, or
"the effect of unequal expansions; when 9644
"consumption occurs it is due to the imper-
"fect charging of the lamp."(Ibid, pp. 65 & 70)

I have thus given sufficient of the testimony of the respective parties to this contest to show what they did respectively, and when they did it.

Edison completed the invention and reduced it to practice on or about October 22, 1879. Sawyer and Man had the invention in a rude form as early as March,

1878, and completed as early as September or October of the same year. The question here is not when was the invention so completed as to compete commercially with gas, but when was it completed as an operating invention?

It may be that it will never prove to be equal to gas commercially, but that will not prove it is not a complete and perfected invention. An invention is complete when the thought conceived is embodied in some
9646 practical and operative form.

It may never prove to be profitable because of other ways devised for accomplishing the same end. This invention was complete in a legal sense when either of the parties to this controversy had devised means by which to demonstrate its practicibility. This was done, not when they with a conductor formed of carbonized paper had produced a light which would continue for a
9647 few minutes, but when they with such conductor had produced one which would last for hours, days and even weeks. Such a light with such conductor was first produced by Sawyer and Man.

In was sought to be shown on the part of Edison that all that was done by Sawyer and Man amounted to no more than experiments leading toward a completed invention, but never reaching the goal, and that such experiments were afterward abandoned. In support of this proposition attention was called to certain letters alleged to have been written by Mr. Sawyer and pub-
9648 lished in the New York *Herald*, and also to a book put forth under his name and shown to have been written by him. If it had not been conclusively shown that Sawyer and Man had perfected their invention and reduced it to practice more than a year prior to the time either of these letters were written, and more than two years before the book was published, some weight might be attached them, but such proof having been adduced, the publications, in any view which might be taken of them, amount to nothing.

When this case was before me in July, 1882, on a motion to re-open it to take further testimony, I stated in my decision: "Taking all the statements of Mr. "Sawyer together without further explanation—I am "compelled to reach the conclusion that the experi- "ments made by himself and Man were not successful, "and that they did not have the invention complete "on December 24, 1879." On a full and careful read- 9650
ing of the testimony the "further explanation" mentioned has been fully supplied. Before the writing of these letters and publications the invention of Sawyer and Man had passed beyond the tentative domain of experiment, and had reached the solid ground of completion by practical demonstration. If it be conceded therefore, that Mr. Sawyer wrote the letters attributed to him, and published the book put forth in his name, they cannot be allowed, either singly or together, to work an abandonment of the invention of Sawyer and
Man. This invention was the product of their joint 9651
efforts, and could not be abandoned by either separately and alone. Mr. Sawyer could not by any act or by any word prejudice the rights of Mr. Man without the consent of the latter. I do not think, however, that it was the intention of Mr. Sawyer to abandon the invention, but, feeling piqued and annoyed by the success of Mr. Edison, he published his letters for the purpose of calling attention to his own and the joint inventions of Sawyer and Man. At the time said let- 9652
ters were written and the book published he was inimical to the owners of this invention, and his habits for sobriety were not good, to say the least. Under such conditions it is not strange he should have written and published what under other circumstances he would not have uttered.

In view of the facts disclosed in the testimony regularly taken in this case, I do not consider any of the statements made by him in his letter or book of any

importance, and hence dismissed them from considera- tion. Neither do I consider, for the foregoing reasons, the question of where the title of the invention was at the time said letters were published of any moment of the decision in this case. The question here is not as to who at that time or now owns the invention of either of the parties, but which of the parties to this record first made the invention. I think it is fully and clearly
9654 shown that Sawyer and Man were the first inventors of the "incandescent conductor for an electric lamp formed of carbonized paper."

The decision of the Examiners-in-Chief awarding priority of invention to Edison is therefore overruled, and priority of invention of the matter in controversy is awarded to Sawyer and Man.

E. M. MARBLE,
Commissioner.

October 8, 1883.

9655 [Endorsement—U. S. Patent Office; Commissioner's Decision; Sawyer and Man vs. Edison; October 8, 1883; Recorded Vol. 25, page 41.]

9656

Defendant's Exhibit Edison French Patent No. 130,910.

Copie du
Mémoire Descriptif
Annexé au
Brevet d'Invention de 15 ans
Pris le 28 Mai, 1879,
par
MR. THOMAS ALVA EDISON, 9658
pour

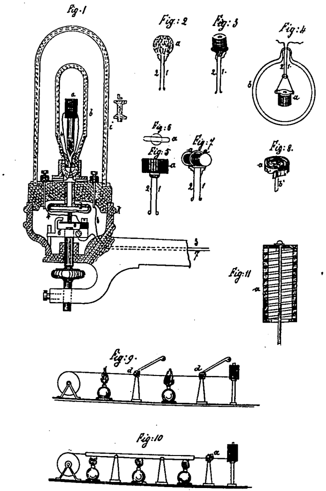
"Perfectionnements apportés dans la production de "l'Électricité, dans la lumière électrique ainsi que "dans les machines et appareils employés à ces "effets."

Dans mon brevet d'invention du 8 Novembre 1878, j'ai décrit et indiqué des moyens pour développer les courants électriques et pour éclairer au moyen de l'élec- 9659
tricité.

Mes présents perfectionnements se rattachent à la dite invention et ils se rapportent à la construction du brûleur à l'ajustement automatique du brûleur, au système de circuits dans lesquels les lumières sont employés, aux moyens pour développer les courants électriques, au mesurage de la quantité d'électricité employé et à d'autres dispositions se rattachant à mon système d'éclairage électrique.

J'ai reconnu que, lorsque des fils ou des feuilles de 9660
platine, iridium ou autres conducteurs d'électricité qui fondent à une haute température sont exposés à une haute température, se rapprochant de leur point de fusion dans l'air, pendant plusieurs heures, en y passant un courant d'électricité, et ensuite en les laissant refroidir, le métal est rompu, et sous le microscope on voit une myriade de fentes suivant différentes directions, dont plusieurs atteignent presque le centre du fil.

[NOT FILMED: PAGES 2416-2450]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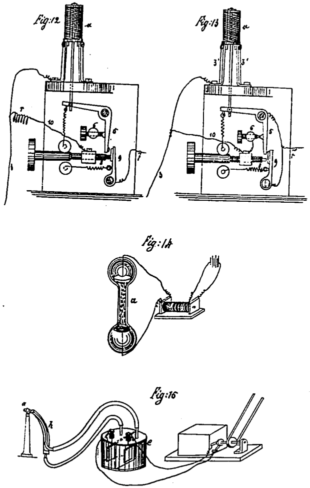
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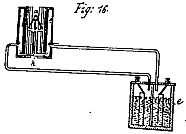

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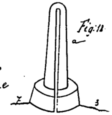

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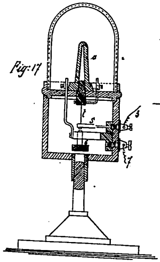

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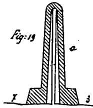

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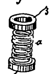

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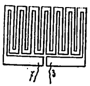

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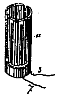

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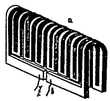

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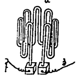

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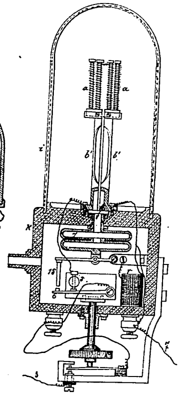

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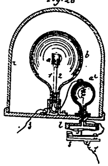

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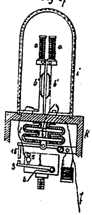

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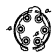

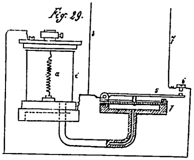

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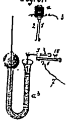

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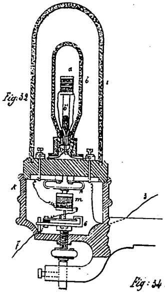

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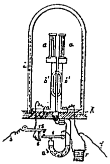

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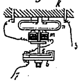

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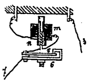

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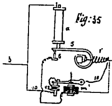

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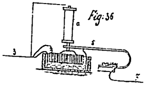

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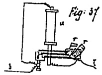

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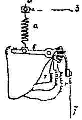

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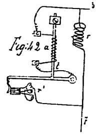


Fig: 42

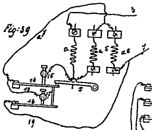


Fig: 39

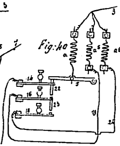
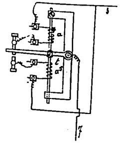


Fig: 40



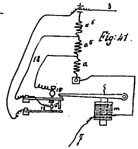


Fig: 41.

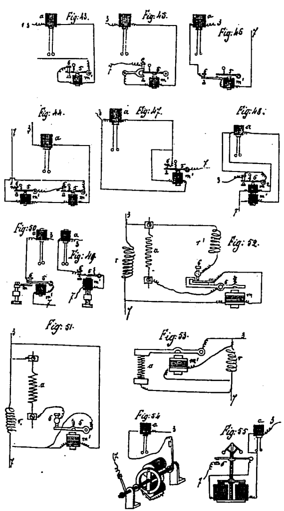


Fig: 43.
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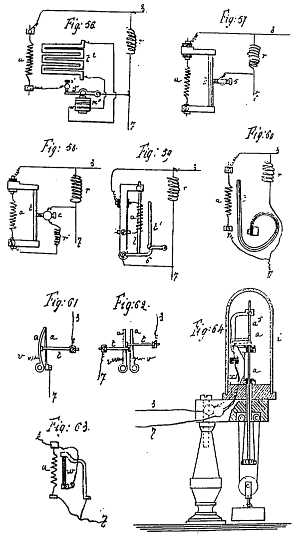
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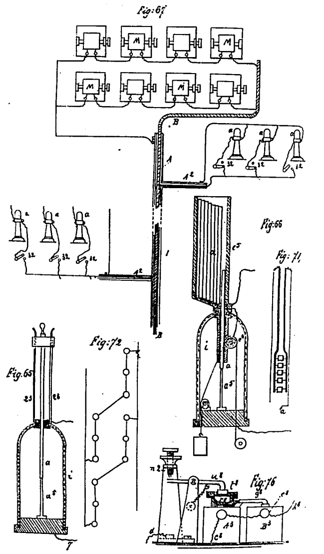
Fig: 67
Fig: 66
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Fig. 65
Fig: 72
Fig: 76

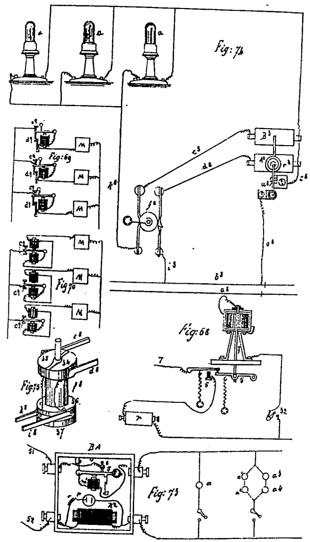
Fig: 74
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Fig: 75
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Edison 3. du 28 Mai 1879.

Fig. 76 A

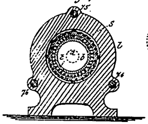


Fig. 79.

Fig. 81.

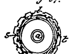


Fig. 77.

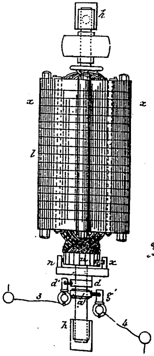


Fig. 78.

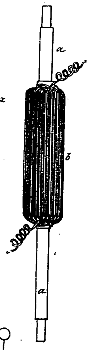


Fig. 80

Fig. 81 A

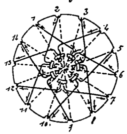


Fig. 82.

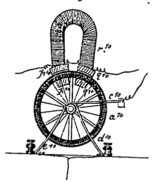


Fig. 81 B.

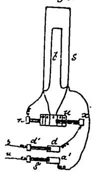


Fig. 83

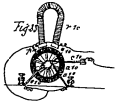


Fig. 84.

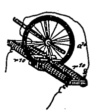
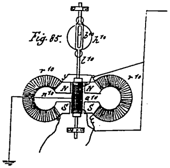


Fig. 85.



Edison .B. du 28 Mai 1879.

Fig. 86.

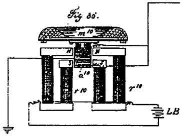


Fig: 87

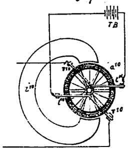


Fig: 88.

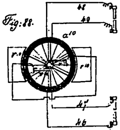


Fig: 89.

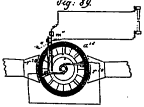


Fig: 90.

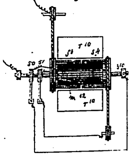


Fig: 91.

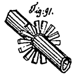


Fig. 92.

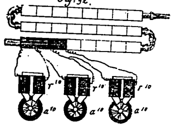


Fig. 93.

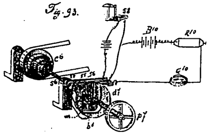
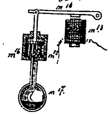


Fig 94.



9913

Defendant's Exhibit Translation of Ediso French Patent No. 130,910.

COPY OF THE SPECIFICATION,

Annexed to the Patent for fifteen years.

Taken the 28th of May, 1879, by

MR. THOMAS A. EDISON, for,

"Improvements introduced in the production of elec-
"tricity, in electric lighting, as well as in the ma- 9914
"chines and apparatus employed for those purposes."

In my patent of November 8, 1878, I have described and shown means for developing electric currents and for lighting by means of electricity.

My present improvements are connected with the said invention, and they relate to the construction of the burner, to the automatic adjustment of the burner, to the system of circuits in which the lights are used, to means for developing electric currents, to the meas-
uring of the quantity of electricity employed, and to 9915
other matters relating to my system of electric lighting.

I have found that when wires or leaves of platinum, iridium or other conductors of electricity which melt at a high temperature, are exposed to a high temperature, approaching their point of fusion, in the air for several hours by passing through them a current of electricity, and then allowed to cool, the metal is ruptured, and under the microscope there appear a myriad
of cracks in different directions of which some reach 9916
nearly to the center of the wire.

I have also found that, contrary to the opinion which has been expressed, platinum or an alloy of platinum and iridium lose weight when they are exposed to the heat of a candle, that even heated air causes them to undergo a diminution of weight, that this loss is so great that it gives a green tint to a hydrogen flame, and under the influence of an electric current to a yellowish-white heat the loss is considerable. After a certain time the metal is disaggregated, from which it

9917

results that platinum or an alloy of platinum and iridium, such as are actually found in commerce, are useless for giving a light by incandescence.

First, because the loss of weight renders them expensive, destroys the burner rapidly and gives no reliability.

Secondly, because their electrical resistance changes on account of their loss of weight and because their emission of light, relatively to the total surface, is con-
9918 siderably diminished on account of the cracks and crevices; the point of fusion being determined by the feeblest point where the greatest difference of potential of the electric current occurs, the effect of which is to create more heat at this point than upon the remainder of the wire; and furthermore for obtaining a stable light it is essential to protect the platinum burner from the contact of air, and when it is thus pro-
9919 tected by being placed in a glass chamber, the glass is rapidly covered with a coating of black from the platinum. A platinum spiral brought to incandescence under these circumstances may be made to give a light equal to three standard candles when it is near its point of fusion and when the radiating surface is a little more than a millimetre and a half, but this amount of light will be gradually reduced as has been above described.

By reason of my invention or discovery I am able to prevent the deterioration of the platinum or its alloys
9920 by destroying or intercepting the atmospheric action. A platinum wire in the form of a spiral or any other form being placed in a glass tube with the wire near its extremities passed through and sealed into the glass, the air is exhausted from the glass tube with a "Sprengel" pump to such a point that the discharge of an induction coil of seventy-five millimetres will not pass between the extremities of wires placed in the tube at a separation of 4 millimetres. The platinum wires of the spiral are then connected to a magneto-electric

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machine or a battery of which the current may be controlled by the addition of a resistance. A sufficient current is passed through the wire to bring it to a temperature of about 65 degrees centigrade, it is left under the influence of this temperature for ten or fifteen minutes; during this heating the air and the gases contained in the metal are expelled from it by the heat or drawn out by the effects of the vacuum. While this
air or these gases are going out of the metal the mer- 9922
cury pump should be worked constantly. After about fifteen minutes the current in the metal is increased so that the temperature will be about 150 degrees centigrade, and it is exposed to this temperature again for ten or fifteen minutes. The mercury pump should be worked constantly and the temperature of the spiral should be raised by intervals of ten to fifteen minutes until it reaches a vivid incandescence, and the glass is contracted where it is joined to the pump and melted
in such a way that the wire is in a perfect vacuum and 9923
in a state hitherto unknown, for the temperature can be raised even to the most dazzling incandescence, giving a light of twenty-five standard candles, while before this treatment the average point of fusion of a series of spirals having the same length and dimensions of wire as well as the same radiating surface was only about three candles.

The wires submitted to this process of elimination of the air and of gas have a polish surpassing that of
silver, and one which cannot be obtained by any other 9924
means. No cracks can be perceived even after the spiral has been suddenly raised to incandescence several times by the current, and no volatilization takes place since no deposit is formed upon the glass tube; moreover, no diminution of weight is found in the wire by the use of delicate scales after it has burned several hours consecutively.

I have further discovered that if an alloy of platinum and iridium or a wire of simple platinum is covered

9925

with a coating of oxide of magnesium in the manner
described below and submitted to the vacuum process
described, a combination takes place between the metal
and the oxide giving to this latter remarkable quali-
ties. With a spiral having a surface of a little more
than a millimetre and a half, a light equal to that given
by forty standard candles may be obtained, while the
same spiral not coated by my process would fuse be-
9926 fore giving a light of four candles. The oxide of mag-
nesium hardens the wire in a surprising manner and
renders it more refractory. A spiral made of this wire
is elastic and forms a spring even when it is heated to
a dazzling incandescence.

I have found that chemically pure iron and nickel drawn into wires and submitted to the vacuum process give a light equal to that of platinum in the open air.

Pencils of carbon can also be freed from air in this
manner and be brought to such a temperature that the
carbon becomes pasty, and if it is then allowed to cool
9927 it is very homogeneous and hard. Rods and plates
made of mixtures of conducting materials finely divided
can also be freed from air and of gases in this way.

I will now describe the form of the burner or lamp
which I employ. In order to operate practically sev-
eral hundreds of electric lamps, each equal to an ordi-
nary gas burner, upon a circuit, it is essential for sev-
eral reasons, as regards convenience, economy, and cer-
tainty of results, to put them all in multiple arc, and in
order to prevent the resistance of several hundreds of
lamps from falling so low that it is necessary to make
9928 use of main conductors of immense dimensions, with a
low resistance, and of machines for generating electric-
ity of corresponding character, it is essential to reverse
the present system of lamps which have a resistance of
only one or two ohms, and to construct lamps which
shall have, when they emit their desired quantity of
light, a resistance of several hundreds of ohms.

9929

I have ascertained by experiment that the loss of
electrical energy is in proportion to the extent of the
surface which emits light, and is independent of the
resistance of the conductors, therefore with a thousand
lamps having each a radiating surface of six millime-
ters and each a resistance of one ohm, the loss of elec-
trical energy is equal to one thousand lamps having
the same radiating surface, each having a resistance of
one thousand ohms; the loss of energy in each lamp in 9930
each case, when it emits a light of fifteen candles, will
be the same, but with one thousand lamps, each of one
ohm, the combined resistance will be a thousandth of
an ohm, from which it results that an enormous
main conductor would be required, while the one thou-
sand lamps of one thousand ohms each, when they are
combined, will have a resistance of but one ohm, and a
conductor of very moderate dimensions will suffice. In
practice, a resistance of two to three hundred ohms will
be sufficient in the burner. With lamps of a low re- 9931
sistance the connections and the main wires should be
large in order to prevent a great loss of energy by the
resistance, and the conducting wires of the main con-
duits are heavy, costly and large to handle. The low
resistance of the burner or incandescent conductor re-
quires large terminals for conducting the current, and
these latter present by their conduction a vehicle for
the rapid dissipation of energy without producing any
effect, while with a lamp of high resistance all these ob-
jections disappear. 9932

The wire for the burner or lamp, prepared as has been above described, is wound upon a bobbin shown at L, Fig. 1, composed of an infusible oxide such as the oxide of calcium, cerum, zirconium, or magnesium freed from silica, formed in a lathe from sticks moulded by hydraulic pressure. The burner complete is shown at *a*, Fig. 1, as being mounted in the vacuum tube *b* upon a rod *b'* composed of the same material as the bobbin. The vacuum tube *t* is supported by the

chamber *k*, and a glass chamber *i* surrounds this tube.
This chamber *i* is sealed in such a way as to intercept
all passage of air for a purpose above described.

Fig. 2 represents a burner or lamp *a* made as has
just been stated, but the pyro-insulated wire is wound
upon a piece of infusible material of spherical form in-
stead of upon a bobbin. I will state that I call the
wire pyro-insulated when it is covered with the metal-
lic oxide above mentioned. In Fig. 3 the bobbin of
9934 pyro-insulated wire is wound upon a mandril from
which it is taken off, and the spires being connected by
metallic wires, the bobbin is then mounted upon a disc
of the infusible material.

In certain forms of lamps it is preferable to support
the burner *a* in the tube *b* by platinum wires 1, 2, as
they conduct less of the heat from the burner than if
it was supported by a rod of lime or other infusible
matter *b'* Fig. 1.

In Fig. 4, the burner *a* is represented as being sus
9935 pended by the platinum wires 1, 2, in the globe *k*.

In Figs. 5 and 6, the bobbin of pyro-insulated wire
a is wound upon a flat cylinder.

In Fig. 7 the bobbin of wire is made of two parts
separated by a central ring of infusible material.

Fig. 8 represents the burner *a* as being made of a
flat band of metal, platina-iridium, wound into a spiral
and supported by a rod of infusible material *b*, this
band should be pyro-insulated.

Fig. 9 illustrates a method of pyro-insulating a
wire. The wire is drawn from a bobbin and passed in-
9936 to the flame of one or several lamps as well as through
sponges *d* containing a solution of lime or magnesium.
The wire in its passage through the sponges is covered
with a coating of this solution which is decomposed and
the oxide deposited upon the wire at the time of the
passage of the wire through the flame.

In Fig. 10 the wire after having received the pyro-
insulating solution passes through a tube which is

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heated by lamps and which effects the decomposition.

Figs. 11, 12 and 13 illustrate another form of
pyro-insulated burner. This burner is made of a flat
wire of platinum-iridium wound spirally, and between
each turn of the spiral there is placed a coating of zir-
conium-magnesium, lime or other oxides of which the
fusing points are very high.

In Fig. 14 the light is produced by the electric spark
which renders incandescent lime which has been pre- 9938
pared by burning an acetate of lime. The prepared
lime is placed in a tube between two metallic discs; as
the prepared lime is very light and porous, the small-
est sparks bring it to the state of vivid incandescence.

Fig. 15 indicates how the lime obtained by burning
an acetate of lime may be rendered incandescent by an
oxyhydrogen flame. *c* is a decomposing chamber con-
taining acidulated water and two electrodes seperated
from each other by a porous diaphragm in such
manner as to form two small cells. The chamber is 9939
provided with a cover, and a tube leads from each cell.
When an electric current is passed through the cells
oxygen and hydrogen are emitted and conducted by
tubes to a chamber or mixing retort *h*, and at the end
of this tube the gas is lighted and the flame projected
upon the prepared lime at *a* brings it to incandescence,
producing a brilliant light by so small a quantity of gas
that it would be difficult to produce any effect if it were
used with the ordinary lime.

The arrangement shown in Fig. 16 is similar to that 9940
which has just been described, except that the burner
is surrounded by two half cylinders of glass into which
the gases of the decomposition cells enter before they
pass into the mixing tube and to the burner.

In Figs. 17, 18 and 19, the burner is made of finely
divided platinum, iridium, ruthinium or other difficultly
fusible metal, incorporated with a non-conducting
material. The burner or candle may be of any size or
form desired, and its particles become incandescent by

9941

the passage of the current and the non-metallic materials are luminous and augment the brilliancy. I mix with these finely divided conductors infusible materials such as magnesium or zirconium in different proportions, in order to obtain the degree of conductivity desired; the materials are mixed together and molded to the form desired for the candle. It is preferable to make use of a split candle such as that shown in Figs. 18 and 19, since the current goes up on one side and
9942 descends on the other.

Figs. 20, 22, 23 and 23[a], represent different forms of burners made from this finely divided material last mentioned.

Fig. 21 represents the material of the burner, indicated in Figs. 22 and 23, laid flat.

In Fig. 24 the burner *a* is made from a curved tube of glass of the form indicated, and is pierced with a very small hole; the air is exhausted from this tube and light is produced by the passage in the tube of a
9943 spark proceeding from an induction coil.

Figs. 25 and 26 represent the burner *a* as being composed of six spirals mounted upon sticks of lime, the spirals being joined together in the manner indicated in Fig. 26 and pyro-insulated.

I will now describe the means for regulating the current in the burners.

In my above mentioned patent the regulation of the current was effected by the heat of the burner or by the intensity of devices working the current which
9944 controlled the current and maintained the light or lights at a uniform intensity. I have still recourse to these methods, but I have modified and improved the devices employed.

In Fig. 1 the burner *a* is situated in the interior of the sealed tube *b*, as has been described above, and the tube *b* is surrounded by a glass globe *i*, mounted upon a holder *k*. A flexible aneroid chamber *l* is cast upon the upper part of this holder or chamber; it opens

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into the chamber formed by the globe *i* in such manner that the air when it is dilated by the heat may pass into the said aneroid chamber and transmit a movement to the flexible diaphragm and parts attached to it. When the current has the desired intensity it enters along the wire 3, passes to the burner, and by the wire 4, to the insulated spring 5 to the contact 6 and to the wire 7. If the current becomes too strong,
causing too great heat to be emitted at the burner, the 9946
air in the globe *i* is dilated and depresses the diaphragm *l*, then a pin mounted on the diaphragm depresses the spring 5, and separates it from the contact 6 which breaks the circuit of the burner at 5 and 6.

This opening and closing of the circuit is only momentary, and therefore the uniform intensity of the light is not interfered with and there is no danger of the burner becoming too highly heated.

In Fig. 25 the air heated and dilated inside the
globe *i* acts in the chambers of the aneroid *l* to close 9947
a branch circuit between 5 and 15, permitting a part of the current to pass through the resistance *r*, and if the heat is maintained, the movement of the lever and the detend 15 upon 5 breaks the circuit of the electric light by separating 5 from 6. The resistance of *r* is equal to that of the burner.

In Fig. 27 a spiral of platinum-iridum wire is shown in the interior of the flexible aneroid chambers, and this spiral is heated by the passage of the current and
heats and dilates the air in the interior of the 9948
chambers *l* to set in operation the levers 15 and 5 as has been above explained.

In Fig. 28 the spiral operated by the heat, is represented as being placed in a small globe a^2 of opaque glass inside of the glass globe *i*. The said globe a^2 and the spiral may be placed inside the case *k*, Fig. 25, in such manner as not to be seen.

In Fig. 29 the heated and dilated air proceeding from the transparent chamber *i* passes into a chamber *l* con-

9949

taining a diaphragm which is moved by this air to open
and close the circuit at 5 and 6 and effect the thermal
regulation of the current.

In Fig. 30 the heated air of the chamber *i* acts upon
mercury contained in a tube a^1, to dilate and contract
it and by means of a float acting upon the lever 5 open
the circuit at 6, 15 to the burner and close it by 15 and
5 and the resistance *r*.

In Fig. 31 the current itself passes through the mer-
9950 cury to heat it and dilate it according to the intensity
of the current, and thus effect the regulation of the
current to the burner by the dilation of the mercury
which operates the float and lever 5.

Fig. 32 represents an axial electro-magnet *m*, placed
in the chamber *k*, and the core of this electro-magnet
is attached to a spring *n*. The current of the burner *a*
passes through the bobbin 12 and, if the strength of
9951 this current does not pass the point required by the
light, the core is not attracted with a force sufficient to
to be lowered apparently. If the current exceeds the
maximum point necessary for the light, then the core
is attracted more and lowered in such manner that a
rod attached to it breaks the circuit at 5 and 6 and the
current sent to the burner is momentarily interrupted,
as has already been explained. The spring *n* serving
to keep the core *m* lifted might consist of a spiral in-
side of a tube within the coil of *m*, as is shown in Fig.
34. The axial magnet might be replaced by the electro-
9952 magnet *m*, Fig. 33, with its cores adjacent to the spring
n, to attract the said spring 5 and break the circuit
when the current becomes too strong.

In Figs. 12 and 13 the regulation of the current, and,
consequently of the heat of the burner, is affected by
the dilation and contraction of the burner itself, which
moves the lever 5. When the current is of the desired
intensity it passes to the burner by the wire 3, Fig. 13,
and by the rod and the lever 5 to the wire 7; if the cur-
rent becomes too strong, the burner *a* expands upward,

9953

moving the lever 5, which makes contact with 6, and
forms a short-circuit for the current through the wire
10. The lever *y* is a safety device for making contact
with the screw 8, and offers another path for the cur-
rent in case that 5 and 6 do not make an electric con-
tact.

The arrangement indicated in Fig. 12 is substantially
the same as that in Fig 13 except that a resistance, *r*,
is placed in the branch circuit. The parts are repre- 9954
sented in the position which they occupy when the
burner is expanded and when the current passes through
the short-circuit and the resistance.

In Fig. 17 the current passes through the rod *t*, and
if it is too strong, this rod expands and brings 5 into
contact with 6 and establishes a short-circuit between
5 and 6 for the current.

In Fig. 35 the expansion of the body *a*, which emits
the light, closes the circuit between 5 and 6, and the
current passes through the electro-magnet *m*, which 9955
attracts the armature lever, and brings more or less
pressure upon the two carbon buttons at 12, through
which the current passes to the short-circuit 10, thus
cutting out the burner; this short-circuit offers more
or less resistance according to the pressure of the ar-
mature lever upon the carbon buttons.

In Fig. 36 the expansion of the body *a* emitting the
light, acts to immerse more or less a coil of wire at one
side in a bath of mercury, and thus augment or dimin- 9956
ish the resistance in the short-circuit or branch-circuit
passing through the mercury in order to divert the cur-
rent if the heat becomes excessive. The continued ex-
pansion of the body *a* emitting the light, Fig. 37, di-
minishes gradually the resistance in the short-circuit
between 3 and 7 by bringing the springs 5 successive-
ly into contact with the contact point 6, and by pro-
viding a short-circuit to the resistance *r*.

In Fig. 38 the continued expansion and contraction
of the body *a* emitting the light, moves the lever 5 and

9957

brings the resistances r successively into circuit, and the second resistance is greater than the first, and so on.

In Fig. 39 3 burners a, a^5, a^6 are shown; the current entering at 3 will not pass through a^5 a^6, because the path of the least resistance is by 15, 14, 18 17, 16 and 19 to 7.

When a is expanded its lever 5 separates 14 from 15 and the circuit should pass from a through a^5 and
9958 through a^7 to 18; from there by 17, 16 and 19 to 7. If the light expands still further, the insulated pin upon 14 presses 16, separating it from contact with 17 and the current is forced to pass from a^5 through a^6 to 7.

Fig. 40 illustrates an arrangement like that of Fig. 39, but the arrangement of circuits is slightly varied.

In the said Fig. 40 the current passes from 3 through the lever 5, and the spring 14 to 7. If a expands from the effect of the increase of current, then the lever 5
9959 moves the spring 14, and its metal pin 22 touches the spring 16, and opens two paths for the current, the one through a, 5, 14 to 17, and the other through a^5, 19, 16, 22, 14 to 7. The continuation of the movement of the lever 5 closes 23 upon the spring 18, and a third path is opened for the current by the path a^6 24, 18, 23, 22, and 14 to 7.

In Fig. 41 the current coming from the line 3, passes through 16, 17, 14 and 15 to the burner a, axial magnet m, and the line 7; if the current increases, the
9960 lever 5 of m is attracted downward, separating 14 from 15, and the current now passes through 3, 16, 17 and the wire 18 to the burner a^5 and a, which weakens the current. If the strength of the current increases, then the magnet m attracts the lever 5 still farther downward, separating 16 from 17, and the current passes through a^6 a^5 and a, which increases the resistance and prevents the fusion of the spiral.

9961

In Fig. 40[a] the expansion of the rod t from the effect of the heat emitted by a burner a moves the lever 5 and intercepts the circuit through the flat burner a and closes the circuit through the other burner a^5.

In Fig. 42 the expansion of the rod t by the effect of the heat emitted by a burner a, operates a lever which withdraws the resistance r proportionally to the strength of the current.

In Figs. 43 to 52 inclusive, the sum of the current 9962
directed to the burner of the body a, which emits the light, and consequently the heat of the said burner is regulated or controlled by the current passing through an electro-magnet or electro-magnets m', the said magnets in each case attract their armature lever 5, and break the contact with b when the current exceeds the strength necessary for maintaining the light at the desired point, thus momentarily interrupting the circuit to the burner, diminishing the current and preventing
all injury to the burner. This arrangement will be 9963
clearly comprehended from an examination of the diagrams. I will, nevertheless, remark that two electro-magnets are represented in Fig. 44 in order that there may be two places where the circuit is opened and closed simultaneously so as to reduce the electric spark.

In Figs. 45 and 46 the circuit is not opened or closed by the direct action of the amature lever 5 but by a lever operated by this part 5. 9964

In Fig. 47 the electro-magnet m' is placed in a branch circuit.

In Fig 48 the magnet m' is constructed with coils of wire through which the current passes in opposite directions, and when it is equal there is no effect upon the amature lever; the bobbin m' is made of coarse wire and is placed in the main circuit with the burner, while the bobbin m^2 offers a high resistance and is placed in the branch circuit which does not pass either through the burner or through m'. The inequality of

9965 the resistance of the burner produced by elevation of the temperature serves to vary the current passing through the branch path, and the core of m', m^2 becomes magnetized and attracts the amature lever 5 and opens the circuit to the burner at 3.

Figure 49 represents the electro-magnet m as being adjustable. By varying the distance between its core and the lever 5 the strength of the current necessary for operating 5 is determined.

9966 Fig. 50 represents an arrangement for obtaining the same result by adjusting the spring m^2 which bears against the lever 5 and which prevents this lever from being attracted until the current passing through the burner and the magnet has acquired the strength desired.

In Fig. 52 the movement of the lever 5 breaks the circuit through the lever a and closes it through the resistance r at the point 6.

In Fig 53 the lever m' compressess together the

9967 turns of the spiral or burner a when the magnet is excited, bringing thus certain of the turns into contact and diminishing the resistance and establishing a short circuit for a part of the spiral.

In Fig. 54 I have represented a miniature electro-magnet machine as being placed in the circuit to the burner a; this machine is put in rotation when the current exceeds the desired point, and it thus places resistance in the circuit and at the same time breaks the circuit to the burner.

In Fig. 55 the machine is represented as being pro-

9968 vided with a governor. When the balls of the governor are raised on account of the increase of the current to the burner and to the machine, the lever 5 is raised and interrupts the circuit at 6.

Fig. 56 represents a thermo-electric battery t^2 in close proximity to the burner a, and in the circuit of the battery t^2, m' is the magnet which becomes active when the heat of the burner exceeds the desired point, and, by means of the lever 5, opens the circuit at 6.

9969

Fig. 57 represents a bar t made of two metals, or other materials which expand unequally, in such manner that the bar t will be bent toward the burner a when the heat emitted by this latter attains the desired point and will interrupt the circuit at 6.

The arrangement shown in Fig. 58 is like that shown in Fig. 57, but when the contact between t and 6 is broken, the circuit to the line is not interrupted, but a new path is opened through the resistance r' which 9970

weakens the circuit to the burner.

Fig. 59 represents the expansion bar t as connected to the lever 6 which, in its turn, is connected to a compound lever t'. When the heat of the burner becomes excessive the expansion of the rod t makes the lever t' move into close proximity with the burner a, and it will absorb a part of the heat and protect the burner against any injury.

Fig. 60 represents a spring bar t made of two metals or materials which expand unequaly; it is turned to- 9971

ward the burner a and will absorb the heat from it when the heat of a exceeds a predetermined point.

Fig. 61 represents the material which emits the light in the form of two carbons a a, placed with their ends slightly seperated from each other. The expansion bar t is placed in circuit with these carbons and it is connected to one of them. The fine spring r tends to seperate the carbons from each other to such an extent as the expansion of the bar t permits.

Fig. 62 is like Fig. 61, but there are two expansion 9972

bars t and both carbon points are movable.

In Fig. 63 is shown a rod or cylinder of black oxide of iron which is a non-conductor of electricity when it is cold but which is a good conductor when it is at a red heat. The wires of the circuit are arranged in such manner that when the burner a has a certain temperature this bar will not be heated sufficiently to allow the current to pass through it as a short circuit, but if the temperature is raised, the bar w becomes heated and the burner is included in a short circuit by a portion of the current passing through w.

9973 Fig. 64 represents a burner of which the two poles are dissimilar, the one being of carbon *a* in the form of rod and the other a fine wire a^5 composed of an alloy of platinum-iridium. The carbon produces the light. The inferiority of contact between the metal and the carbon creates a considerable resistance, and this inferiority of contact is increased as these pieces are heated, from which the carbon becomes excessively incandescent.

9974 I have represented the carbon as being held against the rod a^5 of platinum-iridium by means of cords, pulleys and a weight. The rod of carbon *a* may be fed downward against the rod of platinum-iridium a^5 by means of a weight attached to the upper part of the carbon, guides 23, 23 being arranged to pass through the openings made in the weights, as is shown in figure 65.

9975 Fig. 66 represents means for automatically feeding the carbons *a*. A case 5", of a length sufficient for holding freely the rods of carbon, is placed above the globe *i* and the floor of it is inclined, with an opening in its lowest part of a size proper for allowing a rod of carbon to pass and extend partially into the globe *i*. The pulley c^5, by means of a cord and weight, keeps a slight friction upon the carbon and tends to feed it downward and maintain it in contact with the platinum-iridium rod a^5. When the upper part of the following carbon advances to take its place its lower end engages

9976 with the tube and bears upon the upper part of the one which is in combustion.

Another part of this invention relates to an arrangement of the main conducting wires for the purpose of obtaining a complete metallic circuit and at the same time taking advantage of the conductivity of the earth in such manner that the mass of metal in one of the conductors may be reduced, the earth and the metal conductor serving at the same time as a protection for the insulated conductors.

9977 Fig. 67 is a diagram illustrating the connections. The magneto-electric machines are shown at M. They may be arranged between the two main conductors A B, in groups or in multiple arc of 3, 4 or more each, and the connections should be made for intensity. I have shown four magneto-electric machines M in each group.

A is a tube preferably of iron, laid in the earth; it constitutes with the earth one half of the circuit. 9978

In the tube is placed an insulated conductor B, formed preferably of a series of strands of copper twisted together in the form of a cable, one of the strands of the cable being suppressed, say at each thirty metres, in such manner that at the end of the circuit there will remain but one. A branch tube A^2 containing a single strand detached from the cable may enter each house or building, and from the ground floor smaller wires are carried to the different parts of the house where it is desired to place lights. 9979

Each lamp *a* should be provided with a contact lever 32, in such a way as to disconnect it from the conducting wires. The generators of electricity at the central station are provided with a constant magnetic field of which the coils are included in the circuit; therefore, if all the lamps fed by the principal conductors are disconnected or separated from them by their contact levers, the circuit will be broken, and no current will pass through these conductors from the station to the lights, and the steam engine works with less power and 9980 with a less expenditure of energy. If under these conditions, the contact lever of a single lamp is turned, the lamp will be connected to the branch wires from the main conductors, the circuit is closed and there passes from the central station only a current sufficient for feeding the lamp because the external resistance determines the strength of the current. In this manner the current will be proportioned to the number of lamps in the circuit. I prefer that each lamp shall have a resistance, when it is incandescent, of about 100 ohms.

9981 After the lever has established contact in such manner as to connect the light to the conductors, the current will pass through the resistance *r*, (see Fig. 68) equal to the lamp, but if the thermal-regulating screw 6 is turned downward, the lamp will be placed in the circuit and the current divided according to the amount the regulating screw has been turned, as has been explained above.

As has been mentioned above, the connection of one
9982 or several lamps causes to be developed at the central station a quantity of current sufficient for maintaining this lamp incandescent; from which it follows that if magneto-electric machines M are arranged for the purpose in tension and in quantity, several hundreds of lamps may be put on between the main conductors, and the reduction of the resistance at the time of putting each lamp in circuit, draws the required quantity
9983 of current from the stations; therefore the greatest economy is attained by arranging that all the resistances outside of the main conductors shall be materials which emit light.

Fig. 69 represents a safety device for enabling magneto-electric machines to be worked in multiple arc. If any one of a series of magneto-electric machines working in multiple arc should stop for any cause and thus produce no useful effect, its wire would act as a mere resistance, and, therefore, all the power of the other machines would pass through this wire and tend
9984 to destroy it and at the same time to produce a momentary reduction in the quantity of light emitted by the lamps; it is, therefore, very important that it should not be possible for such accidents to occur.

M M M are electro-magnetic machines arranged in multiple arc and connected to the main conductors. Between one main conductor and each machine is placed an electro-magnet wound with very coarse metallic wire in such a way as to offer but a feeble resistance and prevent a loss of energy by heating. Each

9985

magnet is provided with a lever and a retractile spring.

Fig. 71 is a small diagram representing several magneto-electric machines arranged in multiple arc and feeding the main conductors with the current. From the extremity of the main conductors two smaller wires return to the station, and a lamp is placed across them or included in the circuit. By this means the condition of the whole circuit is represented at the central station. 9986

Fig. 72 illustrates the method of arrangement for the lamps placed in the streets in multiple arc between two main conductors.

Fig. 73 illustrates a method for measuring the quantity of electricity employed. B^A is a box into which pass the wires 50, 51 proceeding from the main conductors, K^2 is a coil of very coarse metallic wire, of which the resistance is proportioned to the number of burners employed in the house. This resistance
is but a part of the resistance of one single lamp. 9987
An electrolytic cell P is employed for the meter. This cell, which contains a neutral solution of sulphate of copper, has two copper electrodes, of which one is very thick while the other is very thin. The small portion of the current which passes into the cell carries copper across and deposits it upon the thin plate; a considerable resistance is interposed at R^1, in order that the resistance of the cell may be only a small
factor. If a lamp is placed in circuit it draws current 9988
from the main conductor and the proportional quantity passing through the cell causes a deposit upon the thin plate, and if another lamp is added a double quantity is deposited, and so on. At the end of any period, say a month, the plate is taken by the inspector to the central office where it is weighed with care. As the deposit of copper upon the thin plate will be proportional to the total quantity of energy passing into the house it will give a correct measure for establishing the price of the electricity used.

9989 I put an electro-magnet m' inside of the box B^4, provided with a retractile lever 5 in such manner that if, for any reason, the current passing to the lamps in the house is greatly excessive, the lever will be retracted.

In Fig. 73 I have shown a lamp a having a resistance of say 1,000 ohms, placed in a branch circuit, and in another branch I have shown 4 electric burners a^1, a^2, a^3 and a^4 forming a lamp. As these burners are
9990 placed in proximity and arranged in two branch circuits, the resistance of each branch being 2,000 ohms, the two branches will have a joint resistance of 1,000 ohms, the same as the resistance of one lamp.

By means of this arrangement, several series of lamps may be placed in branch circuits between the same main conductors, and the resistance will be equal in each branch, the radiating surface of the burners being reduced.

Fig. 74 shows how secondary batteries may be em-
9991 ployed for storing the electricity before it is used for operating the lamps a. The main line a^8 is connected with an electro-magnetic machine or to sources of electrical energy.

b^8 is the return metallic wire or the ground connection. The main line a^8 is connected by the metallic wires c^8 to secondary batteries A^3, B^3, and the return wires d^8, e^8 pass through the contact lever f^8, and the wire i^8, b^8. The electric lamps a are shown in branch
9992 circuits between the wires h^8 and k^8. The wire h^8 is connected to one terminal of the secondary batteries A^3, B^3, and the wire k^8 to the lever f_8. This lever, shown as insulated in Fig. 75, is cylindrical, made of two insulated half cylinders 34 and 35, against which the springs e^8 and d^8 bear, and this instrument may be turned periodically by hand, by clockwork or any other proper mechanical means. When the lever f^8 takes one position the main circuit is closed through a_8, c^8, A_3, d_8, 34, 36 and i^8 to b_8, and the secondary circuit is

9993

closed from B^3 through h^8, the lamps a, the wire k_8, the lever 35, 37, and the wire e^8 to B^3. When the lever f^8 occupies the other position the main circuit from a^8 passes by c^8 to B^3 and by e^8, 34, 36 and i^8 to b^8, while the secondary circuit proceeding from A^3 is through h_8, the lamps a, the wire k^8, 37, 35, and the wire d_8 to A^3, in such a manner that when the secondary battery B^3 supplies the accumulated electricity to the lamps a, the main current charges the secondary battery A_3, 9994
and vice versa.

When the secondary battery is completely charged the decomposition of the liquid commences and gases are developed. I take advantage of these effects to operate a circuit regulator and to disconnect the main circuit. The two closed cases in which the secondary batteries are placed are provided with tubes g^8 (see Fig. 76), passing to a chamber r^8 under a flexible diaphragm f^8 and in the metallic circuit c^8, there is a lever
u^8, which is operated so as to interrupt the electric cir- 9995
cuit to the secondary batteries between u^8 and a screw v^8, when the gases are accumulated sufficiently to move the diaphram. The gases accumulated on the interior of A^3 and B^3 combine and in forming maintain the electric action of the secondary batteries. In proportion as the pressure decreases the circuit is closed anew the lever u^8.

Another part of this invention relates to the construction of electro-magnetic machines. In this ma-
chine I make use of a cylinder of which the surface is 9996
covered with a wire wound in the direction of its length and parallel to the axis of rotation. The electric current passing through the coiled wire converts the cylinder into a magnet, one side of the cylinder is of north polarity, and the opposite side of south polarity. An iron shell is employed, inside of which this magnetic cylinder is turned, and by induction the shell becomes magnetized, from which it results that the magnetic forces in the shell turn about this latter in

harmony with the rotating magnetic cylinder. There
is a space between the rotating magnetic cylinder and
the interior of the shell, and in this space are placed
longitudinal wires connected in a very peculiar man-
ner to a commutator, and in these wires there is estab-
lished a current of inducton resulting from the mag-
netic forces in rotation which traverse and cut these
wires during the rotation of the magnetic cylinder on
9998 the interior of the shell, and by the commutator the
current is directed upon the line wires.

In the drawing, Fig. 77 is a plan of the complete
magneto-electric machine. Fig. 76[a] is a transverse
section on the line x x. Fig. 78 is a plan of the rotat-
ing magnet. Fig. 79 is an end view. Fig. 80 a plan of
the shell surrounding the rotating magnet and the in-
duction bobbin. Fig. 81 is an end view of it. Fig.
81[A] is a diagram showing the method of winding the in-
duction bobbin and Fig. 81[B] is a diagram of the con-
9999 nections of the circuit.

The shaft *a* is provided with a cylinder *b* of iron; it
may be solid or hollow, and of cast iron, or of coiled
metallic wires; the wire passing radially from the
shaft goes up along one side of the cylinder across the
other end returns again on the other side, across the
end and so on until all the surface of the cylinder is cov-
ered with wires which are parallel with the axis of the
cylinder. One extremity of this insulated wire passes
along the shaft in a groove to the insulated ring *a'*,
10000 and the other extremity is connected to the commuta-
tor spring or brush *n* which is insulated upon a disc *g*
attached to *a'*, and turning with the shaft *a*, the other
commutator and its spring *x* is attached to the ring *d*
upon the shaft *a*.

The spring *d'* bears against the ring *d*, and the line
wire 3 is attached to it, and the spring *g'* bears against
the ring *a'*, and the return wire 4, or the ground is at-
tached to it, or vice versa. It should be understood
that the magneto electric machine may be employed in

a circuit containing electric lamps or any other instru-
ment or device operated by electricity to which the
current generated may be adapted. The shaft *a* is
mounted in parts or frames *h* and put in rotation by
a proper motive power. The envelope *b* is built up of
iron wire coiled, or of rings of iron held together by
bolts 5, and between the rings there are leaves of paper
or other insulating material in order to separate them
and prevent magnetic currents from circulating in the 10002
direction of the axis of ratation, but the rings are each
magnetized by induction from the magnetic cylinder *b*,
and the lines of magnetic force radiate from the cylin-
der to the rings, and in proportion to the rotation of
the cylinder inside of the shell these lines of magnetic
force are moved around rapidly with the magnetic
cylinder.

In electro-magnetic machines the strongest currents
are produced in the wires which are passed across the
lines of magnetic force. This is why I place the longi- 10003
tudinal wires in the space between the rotating mag-
netic cylinder and its shell in order that these wires
may be traversed by the lines of magnetic force during
its rotation. The induction bobbin is composed of par-
allel wires, *s*, upon the surface of the thin cylinder *t*.
These wires cross the end of the cylinder *t* at the oppo-
site end where the commutator bars *u* are placed at the
commutator end: these wires are united to a circular
range of bars, *u*, which are insulated and upon which
bear the springs. 10004

The wire of the parallel induction bobbin is in effect
endless, and it is coiled with a view to obtain a contin-
uous current. The diagram Fig. 81 represents the
mode of winding the wires. The number of parallel
windings may vary more or less, but I find that the
desired object may be obtained in the best manner by
making use of an even number of parallel windings lon-
gitudinally to the case and of an uneven number of
commutator plates.

10005

The current generated in the wires on the interior of the magnetic field of the north pole will all follow one direction, and the currents generated in the wires in the field of the south pole will be all in the other direction.

I wind the wires in such a manner that while the wire is continuous and the current passes in all the wire the current will pass by two wires of the induction bobbin to a commutator plate, then separating, will pass through an opposite plate of the commutator, and will
10006 pass through into the bobbin in which it will circulate to the other commutator plate. Suppose that the springs bear upon the commutator plates *a* and *c*, the current will be directed toward *a* from the wires 1 and 6, leaving from *c* by the wires 12 and 7. By following the arrows it will be seen that all the winding is a complete circuit in which the parallel portions of the wires in the south field of the magnetic influence have a current developed in one direction, and in the north field in another direction, obtaining thus the dynamic effect, and there is produced no interruption or pulsation of
10007 the current, the spring touching one commutator plate before leaving another.

It should be understood that the current is reversed in the parallel portions of the wires successively; for example, the current in 7 and 14 is reversed while the magnets and the brushes turn around them together, when the spring passes from *d* by 14 to 7 in the opposite direction and to 12 as before. When the spring passes from *n* to *g* the current in 8 and 7 is reversed; it passes from 6 as before, and in passing it is reversed in
10008 *i*, and returning in 8, following the opposite directions, it is taken off by *g*. The broken lines indicate the successive changes of direction, from which it results that the currents are sent by two wires to each commutator successively from the entire magnetic field.

The current will pass from the spring *g'* through *a'*; from there by the parallel wires wound upon the cylinder *b* to the commutator *n*; from there through the bar

10009

upon which it rests along the parallel induction bobbin upon one side of the cylinder *t* returning along the other side to the commutator bar, through the spring *x* to the ring *d* and to the spring *d'* to the line. It should be observed that the parallel induction bobbin *t* and the commutator bars *n* remain stationary and that the springs *n*, *x* turn about the bars *n* by the movement of the shaft *a* and the commutator springs should be placed relatively to the rotary magneto cylinder in 10010
such a manner as to take off the current from the place where it has the greatest strength.

The current will be continuous or nearly continuous and will follow one direction. There will nevertheless sometimes be a spark between the commutator bars when the circuit of the parallel induction winding is interrupted, but this will be diminished by curving the commutator springs in such a manner that they bear upon more than one commutator bar. It will be evident that the case and the parallel induction winding 10011
may be put in rotation if the magnetic cylinder remains stationary or if it turns in the opposite direction, and I call attention to the fact that the cylinder supporting the parallel winding of induction *s* may be constructed of any proper material, but I prefer and I make use of vulcanized fibres.

The parts of this machine are not subject to heating under the conditions of ordinary use because the wires are not wound one upon the other and the air can circulate in the mass. Nevertheless in certain cases I 10012
make use of a ventilator upon the shaft *a* mounted in a case communicating with the internal portions of the machine in such a manner as to produce a current of air in them.

Fig. 82 represents a new form of dynamo electric machine in which the magnetic field is concentrated and the wires of the bobbin cut the field with great rapidity and the quantity of wire passing through the field may be increased almost to any amount desired

10013 without increasing the speed of rotation of the shaft. a^{10} is a ring composed of iron wire; about this ring is wound insulated metallic wire in sections of which there are several hundred. The metallic wires between the sections are connected, as in the Gramme machine, to the commutator. r^{10} is the field magnet which may be excited from the ring a^{10} or from an external source. It is provided with poles p^{10}, p^{11}, q^{11}, q^{11}, which are shown in section. In the actual machine these
10014 poles cover the ring entirely except a small slot into which the spokes of the ring are fitted. c^{11} is a commutator spring which, following all the positions of the ring, establishes communication to the bobbin through the field magnet. d^{10} and e^{11} are also springs connected together and connected also by the commutator cylinder with the coils upon each side of the field-magnets. That portion only of the wire upon the ring in
10015 proximity to the field-magnet is employed, or adds a resistance to the circuit, in such a manner that the resistance of the wire, the length of the magnet, and the concentration of the field are independent of the diameter of the ring, which may have a diameter of some meters. This is not true of the Gramme ring, for if it is desired to increase the speed with which the wire passes through the field the ring should be greater, but this will increase the resistance, and, as the whole of the field should be covered by the field-magnet, it should be distributed in such manner that there would
10016 result from it a weakening of the field, which prevents high speed except with an accelerated rotation of the shaft which increases friction.

When the ring in my machine is put in rotation in the magnetic field, a current passes through the wire wound upon each side of the magnet, the one proceeding from c^{10} and the other from d^{10}, both of them in the same direction, and it is sent from the machine to a lamp or other electrical device.

10017

Fig. 83 represents the same machine arranged with the wire wound on the field magnet in the same circuit as the wires of the ring.

Fig. 84 represents a double field magnet r^{10} with a ring passing across the pieces of the pole at its center. The 2 north poles of the machine are connected to one piece and the 2 south poles to another.

Fig. 85 represents this system arranged with mechanism for reciprocating action.

c^{10} is a shoft, h^{10} an eccentric, a^{10} is a magnet cov- 10018
ered with wire which receives an alternate action from the eccentric and the rod l^{10}. r^{10} is the field magnet; S S are the south poles and N N the north poles. A metallic wire a^{10} is attached to the center of the wire upon a^{10}. The two other extremities of a^{10} are united together and form the other pole. Alternating currents are generated in the bobbin a^{10} by its reciprocating action between the magnetic poles, and these may, by means of a commutator, be changed into continu- 10019
ous currents.

Fig. 86 represents this principle applied to a telephone; m^{10} is its diaphragm; a^{10} the iron envelope and wire excited in the magnetic field by the movement of the diaphragm a^{10}. S S are the south poles and N N the north poles of the magnets r^{10}; the wires are connected as in Fig. 85. It is well understood that permanent magnets may replace the electro-magnets r^{10}. I have shown a local battery L B for polarizing the magnets in a permanent manner, but these magnets 10020
may be placed in the main circuit with a^{10} and the battery may be connected in the line.

Fig. 87 indicates how the additional field-magnet of a Gramme machine may be suppressed and the ring itself made a field magnet, and a magnet traversing it at the same time. Assuming T B to be a thermal battery or other source of electrical energy, the current would pass to the ring by the commutator springs t^{10}, passing from above and below the iron ring a^{10}, N and

10021 S respectively. i^{10} is a mass of iron merely. e^{10}, e^{18}, are the usual commutators. If these last are closed and the ring set in rotation, the current generated tends to make a north pole at the right and a south pole at the left from which the polarity of the ring is angular relatively to the iron piece i^{10}, from which the attraction which tends to retard the rotation in this generates currents.

Fig. 88 represents an arrangement by which continu-
10022 ous currents and alternating currents may be obtained from an ordinary Gramme machine. The commutators v^{10} are either closed or arranged with the wire upon the field magnet in such a manner that the current generated in the machine will excite the field magnet in a direction at right angles with the commutator springs as well upon the upper side as upon the lower side of the ring; also the continuity is broken and the two extremeties of the wire are carried to discs upon the shaft upon which springs bear, and these springs are at-
10023 tached to wires, and if these wires are closed, continuous currents are taken off from v^{10}, and they will excite the field magnets while alternating currents will pass from these circuits. 46, 47, 48 and 49 are circuits connected to carbon points forming a spark lamp or voltaic arc.

Fig. 89 represents the upper side only of the annular bobbin a^{10} in section, with its two extremeties connected to discs or rings upon which bear the springs n'' and m''.

10024 Fig. 90 represents a dynamo electric machine for quantity; s^{10} is its shaft; m^{12} a magnet with wires, the two extremities of which are connected to discs 50 and 51; S^3 and S^4 are shells of copper which surround the magnet m^{12} at the centre; the shells make an electric conection with the soft iron of the magnet m^{12}. On the end of the shells are metallic pulleys. Flexible metallic cables serve to communicate rotation to the shells and to convey the current; these shells turn in opposite di-

10025 rections. The currents conveyed by them pass through the iron core of m^{12}, and the shaft becomes one terminal of the circuit while the pulleys and metallic cables form the other terminal of it. One shell supplies current to the field magnet r .

I will mention that to regulate the force of the currents in a Gramme machine, the two commutator springs or brushes may be attached to a rotary disc, and if this disc is placed at right angles with its proper position 10026
no current is generated or power absorbed for the machine, but if it is turned a very small amount towards the position desired for obtaining the maximum current, then a current is generated proportionately to this movement, and hence, by turning the commutator, a current of any force desired may be obtained without stopping the machine or causing a greater absorption of power than that necessary for generating the current.

Fig. 91 represents a tube through which flows hot 10027
water, and its entire circumference is to be covered with thermo-electric couples in the form of radiating plates. It is recognized that a large part of the theoretical energy of the combustion of carbon in a steam boiler is lost from the fact of the condensation of the hot water in a good conductor. As a stream flows with a fall of water of about two millimeters to a kilometer, I propose to arrange several meters of a pipe passing into a chamber in one direction and the other several times and to pass the hot water of the condenser 10028
through this length of pipe to the cistern, and I propose to extract the heat from it by covering the entire surface of the pipe with thermo-electric batteries. The hot junctions of the thermo-battery bear upon the surface of the pipe, which is a non-conductor of electricity, and if it is necessary, in order to obtain an increase of effect, the other junctions are placed in contact with another series of pipes in which there circulates cold water. These thermal couples are connected together

10029

in a proper manner so that their currents may be utilized for maintaining a constant field magnet for magneto-electric machines which I employ in my system of lighting. A certain portion of pipe is reserved for the thermal battery of each magnet. r^{10}, Fig. 92, represents these magnets in magneto-electric machines. The thermal batteries are admirably adapted for this particular service because the resistance of the field magnets may be very low.

10030 Fig. 93 represents a dynamometer for measuring the motive power absorbed by dynamometric machines while they furnish a current. C^6 are pulleys mounted upon a shaft s^6. These pulleys are driven by a belt 54. 55 and 56 are insulated discs mounted upon the shaft s^{16} springs bear upon these discs. d^7 is a disc permanently attached to the shaft s^6; m^6 is an electro-magnet also permanently attached to the disc d^7. It carries an amature upon the extremity of an arm which is attached to an idle pulley p^7 or to a sleeve attached

10031 to the said pulley, which is also idle upon the shaft s_6. From the pulley p^7 there extends a belt to the dynamo machine. The springs 55 and 56 form a connection with a battery B^{10} a resistance R^{10} and a galvanometer G^{10}. 55 and 56 are connected to the magnet m^6 and 55 is connected with the disc d^7 and 54 with the back contact b^8 which establishes a circuit when the arm of p^7 bears against b^8 in which circuit are mounted a bell and a battery 58.

10032 The dynamo machine will be driven by a belt proceeding from p^7, and, when it is desired to ascertain the amount of power absorbed by the dynamo machine, the battery B^{10} is put in circuit and m^6 attracts the arm of p^7 from b^8 to the soft iron of the magnet m^6 and the strength of the magnet should be sufficient to hold the arm while the rotation continues. The operator now watches the galvanometer and commences to insert resistance in the circuit until the power of the magnet is weakened to such an extent that the arma-

10033

ture upon the arm p^7 ceases to be held by the soft iron and the armature lever falls back upon b^8. This closes the circuit of the bell and just at the moment when the bell is heard the operator notices the deflection of the galvanometer which gives the strength of current proceeding from B^{10}; having previously determined the amount of weight which would withdraw the arm contact with m^6 with different strengths of current, he can, by taking the speed of rotation, calculate with precision the force absorbed in kilogramme-meters. 10034

Fig. 94 represents an arrangement for measuring the amount of current consumed in a given time. m^{13} is an electro-magnet; m^{14} a lever attached to a piston working with precision in a cylinder m^{15}. m^{16} is glycerine or oil. This cylinder is connected with the reservoir m^{17} by a tube having a very small hole at one end. The measurement is obtained by the pressure produced by the magnet upon the piston which forces the oil very slowly into the reservoir but in proportion to the attraction of the magnet which is as the square 10035 of the electro-motive force of the current.

I claim as of my invention.

First.—In combination with a sealed vacuum chamber made of glass, a continuous metallic incandescent conductor, as above described.

Second.—The method above described of preparing electric conductors for electric lamps or burners, consisting in freeing the metallic conductors from gases in 10036 a vacuum and afterwards in sealing hermetically the air-tight transparent chamber in which they are enclosed, as hereinbefore specified.

Third.—In an electric lamp, the combination with a transparent sealed vacuum chamber of a bobbin of pyro-insulated wire wound upon an infusible material, as hereinbefore specified.

10037

Fourth—The combination with a transparent vacuum chamber of a continuous conductor forming an electric burner or candle and a second transparent case forming a closed chamber for the purpose hereinfbeore set forth.

Fifth.—The combination of the conductor forming the electric lamp or candle, with the scale l transparent case *i* containing the case *h* and the thermostatic regu-
10038 lator *l* 5, 6, as hereinbefore specified.

Sixth—The method of pyro-insulating the wire or strip of metal for the conductor consisting in passing the wire or strip through a solution of lime or magnesia and then through a flame or a fire for effecting the decomposition of the solution, as hereinbefore specified.

Seventh.—The combination in an electric light of
10039 layers of incandescent metal with intervening pyro-insulators, as hereinbefore described.

Eighth.—A spiral or helix of metal with intervening pyro-insulators, solidly compressed, in combination with the thermal circuit regulator, as shown in Figures 12 and 13.

Ninth.—The combination with a continuous incandescent conductor forming a burner or lamp, of a rheostat or resistance and circuit connections, as shown in
10040 Fig. 12, for maintaining a nearly uniform resistance in the electric circuit, as hereinbefore specified.

Tenth.—The combination with the electric light *a* and the thermal expansion device, Figs. 12 and 13, of the levers 5 and 9, and the contact points 6 and 8 and circuit connections, as hereinbefore specified.

10041

Eleventh.—The method of producing an electric light which consists in passing an induction spark through lime contained in a vacuum tube, as described by reference to Fig. 14.

Twelfth.—The material produced by burning an acetate of lime for utilization in electric lighting, as hereinbefore described.

Thirteenth.—The apparatus shown in Figures 15 and 10042
16 for producing an oxyhydrogen light, as hereinbefore specified.

Fourteenth.—In electric lighting, a conductor of electricity formed of finely divided metal incorporated with a non-conductor of electricity, as hereinbefore described by reference to Figs. 17, 18, 19, 20, 21, 22, 23 and 24.

10043

Fifteenth. A rigid body for emitting electric light, Figs. 17, 18 and 19, having a cut or longitudinal separation from the base to nearly the extremity for securing the circulation of the electric current in the entire body, as hereinbefore specified.

Sixteenth.—In combination with a rigid body *a* emitting the electric light and having a longitudinal incision, a thermal expansion regulator for the circuit 10044
for controlling the strength of the current by the effect of the heat developed in the burner, as hereinbefore specified.

Seventeenth.—A thermal regulating spiral in the same circuit as the burner, but in an air-tight case separated from the said burner, and operating apparatus regulating the circuit, as described by reference to Figs. 27 and 28.

Eighteenth.—The axial magnet *m* in the circuit of the body *a*, which emits the light in combination with the spring *n*, to which the core of the magnet is attached, the spring 5, the piece *b* and the circuit connections, as hereinbefore specified by reference to Figs. 32 and 34.

Nineteenth.—The apparatus and circuits represented in Figs. 35, 36, 37, 38 and 42, for varying the resist-
10046 ance in the circuit to the burner according to the intensity of the current passing to said burner.

Twentieth.—The apparatus and circuits represented in Figs. 39, 40, 40ᴬ and 41 by means of which one or several bodies emitting light are placed in the circuit with the principal burner, if the burner becomes too intense, which has the effect of reducing the current in the said principal burner, as hereinbefore specified.

Twenty-first.—The combination with a metallic body
10047 emitting light of one or several magnets through which the current passes to the burner, and the electric circuits shown, by which the quantity of current sent to the burner is regulated by the current passing through the said magnet or the said magnets, as hereinbefore described and shown in Figs. 43 to 48.

Twenty-second.—The combination with the body *a* emitting the light of a small electro-magnetic machine in the circuit of the burner, as hereinbefore described by reference to Figs. 54 and 55.
10048

Twenty-third.—The combination with the burner *a* the electro-magnet *m*, the thermal battery r^2 and circuits arranged as shown in Fig. 56.

Twenty-fourth.—The combination with the burner *a*, of the expansion rod *t* and electric circuits arranged as shown in Figs. 57 and 58.

Twenty-fifth.—The combination with the burner *a*, of the bar *t* or *t'* absorbing the heat, Figs. 59 and 60.

Twenty-sixth.—The carbon *a* which emits the light, pivoted at one of its ends and with its other end contiguous to the other carbon, in combination with the expansion rod *t* and the spring *r*, as hereinbefore specified and shown in Figs. 61 or 62. 10050

Twenty-seventh.—The combination with the body *a*, which emits the light, of a bar *u*, Fig. 63, which is a non-conductor of electricity when cold and a conductor when hot for regulating the current in the burner, as hereinbefore specified.

Twenty-eighth.—The combination with an electric lamp, of a pencil of carbon and a refractory metallic rod, and a weight for maintaining the necessary pressure at the point of contact, as hereinbefore shown. 10051

Twenty-ninth.—The case e^5 with an inclined floor adapted for receiving several carbon pencils, in combination with the metallic rod a^5, Fig. 66, and means for guiding these pencils and maintaining their pressure at the point of contact, as hereinbefore described.

Thirtieth.—The insulated metallic conductors B, Fig. 67, within a metallic case which constitutes, with the earth, the return circuit, as hereinbefore described. 10052

Thirty-first.—The automatic safety device, Fig. 69 or 70, for interrupting the current to the electro-magnetic machine in case of derangement of the said machine.

Thirty-second.—The method specified by reference to Fig. 73 for determining the electric current employed in the electric lamps, which consists in causing metal

10053 to be deposited by the current which passes, in weighing this deposited metal and in estimating in this manner the value of the current employed, as hereinbefore described.

Thirty-third.—The arrangement of 4 electric lamps, Fig. 78, in a divided branch circuit between two main conductors, as hereinbefore described.

10054 *Thirty-fourth.*—An electro-magnet, *m'*, Fig. 78, placed in the circuit of the burner in a building, which operates when the current exceeds a predetermined point to attract an armature lever and hold it and interrupt the circuit to such burners, as hereinbefore described.

Thirty-fifth.—The combination with the electric lamps *a*, Fig. 74, and with a main circuit of 2 secondary batteries and circuit connections for changing 10055 alternately the main and secondary circuits, as described.

Thirty-sixth.—The secondary circuit containing electric lamps, the secondary battery and the case in combination with the main circuit through the secondary battery, a diaphragm operated by the accumulation of gas in the secondary battery and a contact lever in the main circuit, as hereinbefore described.

10056 *Thirty-seventh.*—A magnetic cylinder *b*, Figs. 76^A, 77, 78 and 79, composed of a cylinder of iron of which the surface is covered with an insulated wire arranged parallel to the axis of radiation and across the ends, as hereinbefore specified.

Thirty-eighth.—The combination in a dynamo-electric machine *a* and with rotary magnetic cylinder *b*, of an iron casing or shell *l* surrounding the cylinder, and insulated wires wound and connected to the commutator,

as hereinbefore described, forming a parallel induction apparatus *s* which occupies the space between the magnetic cylinder and the envelope, as specified. 10057

Thirty-Ninth.—The combination in a magneto-electric machine of a rotary magnetic cylinder *b* carrying metallic wires along its surface parallel or nearly parallel to the axis, a metal shell *l*, a parallel induction bobbin *s*, of commutator bars *u*, springs *n x*, rings *d e* 10058
and the circuit connections described.

Fortieth.—In an electro-magnetic machine, a paralle-induction bobbin, of which the metallic wires are wound in the manner shown in Fig. 81^A and commutator connections to these wires by which the current is taken off from the parallel induction bobbin at two opposite points or directions, as described.

Forty-first.—The rotary induction bobbins, stationary magnets, commutators and circuits shown and de- 10059
scribed by references to Figs. 82, 83, 84, 87, 88 and 89.

Forty-second.—The induction bobbin having a movement in the direction of its length, the electro-magnets and the circuits described and shown by reference to Figs. 85 and 86.

Forty-third.—The apparatus shown in Fig. 93 for determining the power consumed for the driving of 10060
magneto-electric machines, as hereinbefore described

Forty-fourth.—The thermal battery and the heating pipe, shown in Figs. 91 and 92, in combination with the electro-magnetic machine, as hereinbefore described.

10061

Defendant's Exhibit No. 1, Edison's Canadian Patent.

CERTIFIED that the annexed is a true copy of a patent registered in the Patent Office under number 10,654, granted to Thomas Alva Edison, and bearing date the seventeenth day of November, 1879, for "Edison's Electric Lamp," with true copies of the specification and drawings remaining on record in this office, duplicate copies of which were attached to the patent
10062 above mentioned, as also Certificate No. 88, of the payment of the fee for a further term of ten years hereto annexed.

DEPARTMENT OF AGRICULTURE,

PATENT OFFICE,

OTTAWA, Canada, January 13th, 1885.

10063 As witness the seal of the Patent Office hereto affixed.

[SEAL.] A. J. CAMBIE,

Actg. Deputy Commissioner of Patents

CANADA.

PATENT OF INVENTION, 10,654.

WHEREAS, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, one of the United States
10064 of America, Electrician, has, in pursuance of "The Patent Act of 1872," by his petition to the Commissioner of Patents, stated that he has invented new and useful improvements on Electric Lamps, and in the method of manufacturing the same, the title whereof is: "Edison's Electric Lamp," not known or used by others before his invention thereof, and not being at the time of his application, in public use, or on sale

for more than one year previous to his said applica- 10065
tion, in Canada, with his consent or allowance, and has elected his domicile at the city of Ottawa, in the Province of Ontario, in Canada; and whereas, the said Thomas Alva Edison has also complied with the other requirements of the said Act,

THE PRESENT PATENT GRANTS to the said Thomas Alva Edison, his executors, administrators and assigns, for the period of five years from the date
of these presents the exclusive right, privilege, and 10066
liberty of making, constructing and using, and vending to others, to be used, the said invention of Thomas Alva Edison, and which is called or known by the title or names of "Edison's Electric Lamp," and whereof a short description is as follows:

It consists: 1st, in an electric lamp for giving light by incandescence consisting of a filament of carbon of high resistance and secured to metallic wires; 2nd, in
the combination of carbon filaments with a receiver 10067
made entirely of glass through which the leading wires pass and from which receiver the air is exhausted; 3rd, in a coiled carbon filament or strip arranged in such a manner that only a portion of the surface of such carbon conductor shall radiate light; 4th, in the method of securing the platina contact wires to the carbon filament and the carbonizing of the whole in a closed chamber.

But for the fuller detail of the invention, reference 10068
must be had to the specification and drawing, one duplicate whereof is hereunto annexed and forms an essential part of this patent.

PROVIDED, that the grant hereby made is subject to adjudication before any Court of competent jurisdiction. And, further, that this patent is subject to the

10069 condition that the same and all the rights and privileges hereby granted shall cease and determine, and the patent shall be null and void at the end of two years from the date hereof, unless the patentee, his executors, administrators, or his assignee or assignees, shall within that period have commenced, and shall after such commencement continuously carry on in Canada the construction or manufacture of the invention hereby patented in such manner that any person desiring to use it may obtain it, or cause it to be made for
10070 him at a reasonable price, at some manufactory or establishment for making or constructing it in Canada.

AND FURTHER, that this patent shall be void if, after the expiration of twelve months from the granting hereof, the patentee, his executors or administrators, or his assignee or assignees, for a whole or a part of his interest in the patent, imports or causes to be imported into Canada the invention for which this patent is granted.

10071 In testimony whereof, the Honorable John Henry Pope, Commissioner of Patents, has hereunto signed his name, and the seal of the Patent Office has been hereto affixed at the City of Ottawa in the Dominion of Canada, this seventeenth day of November, in the year of Our Lord, one thousand, eight hundred and seventy-nine.

J. H. POPE.

Countersigned,

10082 J. C. TACHE,

Deputy Commissioner.

OTTAWA, November 16th, 1881. 10073

The patentee having adduced proof that he has been for reasons beyond his control prevented from carrying on the manufacture of his invention within the two years mentioned in section 28 of the Patent Act of 1872, further delay of three months is granted to him.

As witness the seal of the Patent Office hereto affixed.

A. J. CAMBIE,

[SEAL] Act'g Deputy Commissioner. 10074

Certificate No. 88, of the payment of the fee for a further term of ten years hereunto annexed.

A. J. CAMBIE,

[SEAL] Act'g Deputy Commissioner.

SPECIFICATION. 10075

To all whom it may concern :—

Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, Electrician, have invented an improvement in electric lamps, and in the method of manufacturing the same, of which the following is a specification.

The object of this invention is to produce electric lamps giving light by incandescence, which lamps shall
have high resistance so as to allow of the practical 10076
subdivision of the electric light.

The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current and at the same time present but a slight surface from which radiation can take place.

10077 The invention further consists in placing such burner of great resistance in a nearly perfect vacuum to prevent oxidation and injury to the conductor by the atmosphere. The current is conducted into the vacuum bulb through platina wires sealed into the glass.

The invention further consists in the method of manufacturing carbon conductors of high resistance so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading wires and the carbon
10078 conductor. Heretofore light by incandescence has been obtained from rods of carbon of one to four ohms resistance, placed in closed vessels in which the atmospheric air has been replaced by gases that do not combine chemically with the carbon. The vessel holding the burner has been composed of glass cemented to a metallic base. The connection between the leading wires and the carbon has been obtained by clamping
10079 the carbon to the metal. The leading wires have always been large, so that their resistance shall be many times less than the burner, and in general the attempts of previous persons has been to reduce the resistance of the carbon rod.

The disadvantages of following this practice are, that a lamp having but one to four ohms resistance cannot be worked in great numbers in multiple arc without the employment of main conductors of enormous dimensions, that owing to the low resistance of the lamp the leading wires must be of large dimensions and
10080 good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and are cemented, hence the carbon is consumed because there must be almost a perfect vacuum to render the carbon stable, especially when such carbon is small in mass and high in electrical resistance.

In the use of a gas in the receiver at the atmospheric pressure, which, although not attacking the carbon, serves to destroy it in time by "air-washing," or the attrition produced by the rapid passage of the air over the slightly coherent highly heated surface of the carbon. 10081

I have reversed this practice. I have discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one millionth
of an atmosphere offers from one hundred to five hundred ohms resistance to the passage of the current, 10082
and that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral and carbonized, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled that as much as two thousand ohms resistance may be obtained without presenting a radiating surface greater than three-sixteenths of an inch; that if such fibrous material be rubbed with a
plastic composed of lamp-black and tar, its resistance 10083
may be made high or low according to the amount of lamp-black placed upon it. That carbon filaments may be made by a combination of tar and lamp-black the latter being previously ignited in a closed crucible for several hours and afterwards moistened and kneaded until it assumes the consistency of thick putty.

Small pieces of this material may be rolled out in the form of wire as small as 7-1000 of an inch in diameter and over a foot in length and the same may be
coated with a non-conducting non-carbonizing substance and wound on a bobbin or as a spiral and the 10084
tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form.

All these forms are fragile and cannot be clamped to the leading wires with sufficient force to ensure good

10085
contact and prevent heating. I have discovered that if platinum wires are used and the plastic lamp-black and tar material be moulded around it, that in the act of carbonization there is an intimate union by combination and by pressure between the carbon and platina and nearly perfect contact is obtained without the necessity of clamps, hence the burner and the leading wires are connected to the carbon ready to be placed in the vacuum bulb.

10086 When fibrous material is used the plastic lamp-
black and tar is used to secure it to the platina before carbonizing.

By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading wires as they will have a small resistance compared to the burner, hence will not heat and crack the sealed vacuum bulb. Platina can only be used as its expansion is nearly the same as that of glass. By using a considerable length of carbon wire and coiling it in such a manner that only a small portion of its entire surface
10087 radiates light I can raise the specific heat of the whole and thus prevent the rapid reception and disappearance of the light which on a plain wire is prejudical as it shows the least unsteadiness of the current by the flickering of the light, but if the current is steady the defect does not show.

I have carbonized and used cotton and linen thread, wood-splints, papers coiled in various ways; also lamp-black, plumbago, and carbon in various forms mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameters, each
10088 wire, however, is to be uniform in size throughout.

If the carbon thread is liable to be distorted during carbonization, it is to be coiled between a helix of copper wire. The ends of the carbon or filament

are secured to the platina leading wires by plastic carbonizable material, and the whole placed in the carbonizing chamber. The copper which has served to prevent distortion of the carbon thread is afterwards eaten away by nitric acid and the spiral soaked in water, and then dried and placed on the glass holder and a glass bulb blown over the whole with a leading tube for exhaustion by a mercury pump. This tube when high vacua has been reached is hermetically 10089
sealed. With substances which are not greatly dis- 10090
torted in carbonizing, they may be coated with a non-conducting, non-carbonizable substance which allows one coil or turn of the carbon to rest upon and be supported by the other. In the drawing Fig. 1 shows the lamp sectionally. *a* is the carbon spiral or thread. *c*, *c'*, are the thickened ends of the spiral formed of the plastic compound of lamp-black and tar, *d* *d'* are the platina wires. *h*, *h*, are the clamps which serve to connect the platina wires cemented in the carbon with the
leading wires *x* *x*, sealed in the glass vacuum bulb. *e*, *e*, 10091
are copper wires connected just outside the bulb to the wires *x*, *x*. *m* is the tube shown by dotted lines, leading to the vacuum pump which after exhaustion is hermetically sealed and the surplus removed.

Fig. 2 represents the plastic material before being wound into a spiral.

Fig. 3 shows the spiral after carbonization ready to have a bulb blown over it.

I claim as my invention : 10092

First.—An electric lamp for giving light by incandescence consisting of a filament of carbon of high resistance made as described, and secured to metallic wires as set forth.

Second.—The combination of carbon filaments within a receiver made entirely of glass through which the leading wires pass, and from which receiver the air is exhausted for the purposes set forth.

10093

Third.—A coiled carbon filament or strip arranged in such a manner that only a portion of the surface of such carbon conductor shall radiate light as set forth.

Fourth.—The method herein described of securing the platina contact wires to the carbon filament and carbonizing of the whole in a closed chamber substantially as set forth.

THOMAS ALVA EDISON.

10094 Menlo Park, N. J.

November 1st, 1879.

Signed in the presence of

S. L. GRIFFIN,

JOHN F. RANDOLPH.

This is the specification referred to in the affidavit of Thomas Alva Edison hereto annexed. Sworn to before

10095 me this first day of November, A. D., 1879.

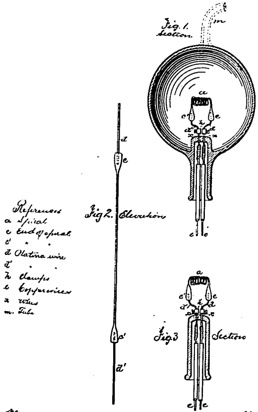
STOCKTON L. GRIFFIN,

Notary Public.

10096

10654

Impt. in Electric Lamps and in the method of Manufacturing the same.



Witnesses
Chas H Smith
Harold Serrell

New York N.J. Nov. 1st 1879.
Certified to be the drawings referred to in the specification hereunto annexed.
Thomas A. Edison
Inventor

per Lemuel W. Serrell
atty

DOMINION OF CANADA. 10105

Patent Office.

88

This is to certify that the Edison Electric Light Company, the holder of Patent No. 10,654, granted to Thomas Alva Edison for alleged new and useful Improvements on Electric Lamps, and in the method of manufacturing the same, bearing date the seventeenth 10106
day of November, one thousand, eight hundred and seventy-nine, has paid to the Commissioner of Patents on the 4th day of May, 1883, the sum of forty dollars, being the fee required for the further term of ten years, to commence and be computed on and from the seventeenth day of November, one thousand eight hundred and eighty-four, as provided by Section 17 of the patent Act of 1872, amended by the Act of 1883.

In testimony whereof I have hereunto set 10107
my hand and caused the seal of the Patent Office to be hereunto affixed, at the City of Ottawa, in the Dominion of Canada, this thirtieth day of October, in the year of our Lord one thousand, eight hundred and eighty-three.

[SEAL.]

J. H. POPE,

Commissioner of Patents.

Countersigned,

A. J. Cambie, 10108

Acting Deputy Commissioner.

10109 (*The following is printed on the back of the foregoing certificate*) :

46 VICTORIA.

CHAP. 19.

An Act to amend the Patent Act of 1872.

(*Assented to 25th May*, 1883.)

Her Majesty, by and with the advice and consent of
10110 the Senate and House of Commons of Canada, enacts
as follows :—

1. Section seventeen of "*The Patent Act of* 1872," is hereby repealed, and the following is substituted therefor :—

"17. The term limited for the duration of every pat-
ent of invention issued by the Patent Office shall be
fifteen years; but at the time of the application there-
for it shall be at the option of the applicant to pay the
10111 full fee required for the term of fifteen years, or the
partial fee required for the term of five years, or the
partial fee required for the term of ten years. In case
a partial fee only is paid the proportion of the fee paid
shall be stated in the patent, and the patent shall, not-
withstanding anything therein or in this Act contained,
cease at the end of the term for which the partial fee
has been paid, unless at or before the expiration of the
said term the holder of the patent pays the fee re-
quired for the further term of five or ten years, and
10112 takes out from the Patent Office a certificate of such
payment (in the form which may be from time to
time adopted) to be attached to and to refer to the
patent, and under the signature of the Commissioner,
or, in case of his absence, another member of the Privy
Council; and in case such second payment, together
with the first payment, makes up only the fee required
for ten years, then the patent shall, notwithstanding
anything therein or in this Act contained, cease at the

end of the term of ten years, unless at or before the 10113
expiration of such term the holder thereof pays the
further fee required for the remaining five years, mak-
ing up the full term of fifteen years, and takes out a
like certificate in respect thereof. Every patent here-
tofore issued by the Patent Office in respect of which
the fee required for the whole or for any unexpired
portion of the term of fifteen years, has been duly paid
according to the provisions of the now existing law in
that behalf, has been and shall be deemed to have been 10114
issued for the term of fifteen years, subject, in case a
partial fee only has been paid, to cease on the same
conditions on which patents hereafter issued are to
cease under the operation of this section."

10117
Defendant's Exhibit Freeman Application.

DEPARTMENT OF THE INTERIOR, UNITED STATES PATENT OFFICE.

To all persons to whom these Presents shall come, Greeting:

10118 This is to certify that the annexed is a true copy from the Files of this Office of the File Wrapper and Contents, in the matter of the Application of Walter K. Freeman, Assignor to Charles R. Flint, Filed July 25, 1881, Serial Number 38,501, for Improvements in Electric Lamps.

In testimony whereof I, C. E. MITCHELL, Commissioner of Patents, have caused the Seal of the Patent Office to be affixed this 21st day of June, in the year
[SEAL] of our Lord one thousand eight hundred
10119 and ninety, and of the Independence of the United States, the one hundred and fourteenth.

C. E. MITCHELL,
Commissioner.

Case A.

In the matter of the application of Walter K. Freeman for Electric Lamps.

10120 TO THE COMMISSIONER OF PATENTS:

SIR—Please recognize Marcellus Bailey of Washington, D. C., as my associate attorney in the matter of the application of Walter K. Freeman for Electric Lamps filed herewith.

PARKER W. PAGE,
Atty. for Freeman.

Case A.

TO THE COMMISSIONER OF PATENTS:

Your petitioner Walter K. Freeman a citizen of the

United States residing at Brooklyn, in the County of 10121
Kings and State of New York, prays that letters patent may be granted to him for the improvement in Electric Lamps set forth in the annexed specification; and he hereby appoints Parker W. Page of the City of New York his Attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent and to transact all business in the Patent Office connected therewith. 10122

Dated the 22nd day of July, 1881.

WALTER K. FREEMAN.

To all whom it may concern:

Be it known that I, Walter K. Freeman, of Brooklyn, in the County of Kings and State of New York 10123
have invented certain new and useful improvements in electric lamps of which the following is a specification:

The lamp to which this present invention pertains may be described in general terms as consisting of an exhausted glass globe or receiver, a strip or filament of carbon and metallic wires passing into the receiver and serving as conducting supports for the carbon, which is united to them by means of clamps. Lamps of this character I have shown and described in another application, 10124
the carbon in the case referred to being composed of a suitably carbonized strip or filament of fibrous material, and the metallic wires sealed directly into the glass, forming the enclosing globe or receiver.

Heretofore, in the case of incandescent lamps, when carbon is employed as the light-giving medium, rods or sticks of graphite or retort carbon have been employed, and these have generally been subjected to a process

10125

for consolidating them in structure and improving their electrical conductivity. When thus produced the resistance is very low, and they necessitate the employment within and out of the lamp of conductors of very large size, which are with great difficulty sealed into the lamp, owing in the main to their tendency to become heated. These lamps are practically run in series only, as the size of the conductors required to supply sufficient current for running any
10126 considerable number of them in derived or multiple cross circuits would be enormous, and would involve the greatest difficulties and expense. Carbons of the kind just described are also exceedingly brittle, and unless of large size and held by supporting conductor of comparatively great diameter are likely to be broken by the jarring of the lamp or the expansion and contraction due to sudden heating and cooling.

The object of my present invention is to remedy the objections which the above described forms of lamp
10127 present. For this purpose I form the incandescent portion of a long slender strip of carbon, preparing it in such a way that it shall be flexible or resilient and shall have a high resistance. By this means the carbons are prevented from clipping or breaking, and the conductors supporting them may be made of such small sizes as to be readily sealed into the glass forming the enclosing case or globe.

The materials which I have found the most servicable for the carbons are those which have a fibrous texture
10128 such as paper, wood and vegetable fibres generally, and the method which I have adopted for producing the finished carbons is to cut out slender strips from the raw materials and carbonize them in a closed retort or muffle. The strips may be cut out in arches or loops, or this form may be given to straight strips by bending them over and retaining them in their bent condition while they are being cabonized. The diameter and length of the strips should be such as to

10129

produce an electrical resistance of at least thirty or forty ohms, though in practice I prefer to make them of a much higher resistance.

In the drawings hereto annexed I have illustrated the lamp forming the subject of this invention, the two figures being central sectional views of the lamp globe taken on lines at right angles. The general character of the lamp is the same as that described in other applications filed by me, consisting of an enclosing globe A, a base D, a slender, loop-shaped carbon conductor 10130
B, and supporting conductors C of metal which are sealed directly into the glass forming the base D and attached to the ends of the loop B by small clamps E.

The carbon loop is produced as above mentioned by carbonizing a strip of fibrous material under such conditions that the access of oxygen to the strips while undergoing carbonization is prevented. The loop is made so slender, and of such length that it offers a high resistance to the passage of the current while it is very flexible and resilient. From this it results that 10131
the carbons while possessing qualities that render it capable of sustaining for a long time the intense heat of incandescence are little liable to be snapped off or broken by the jarring incident to handling and transportation, and readily yield to the sudden changes in shape produced by the expansion and contraction due to makes and breaks in the current.

By making the carbons of high resistance a much larger number may be run from comparatively small 10132
sized main conductors; and the leading-in wires are not heated so as to injure the points of sealing.

Having thus described my invention, what I claim as new and desire to secure by letters patent is:

1st. A conductor for electric lamps adapted to give light by incandescence consisting of a strip or loop of carbon of high resistance substantially as herein set forth.

10133

2nd. A conductor for electric lamps adapted to give light by incandescence consisting of a flexible strip or loop of carbon substantially as herein set forth.

3d. A conductor for electric lamps adapted to give light by incandescence consisting of a flexible carbon strip or loop of high resistance as above described.

4th. An incandescent electric lamp consisting of a
10134 flexible carbon strip or loop of high resistance hermetically sealed within an enclosing globe or receiver made entirely of glass substantially as described.

5th. The combination of a flexible carbon strip or filament of high resistance, an exhausted enclosing globe or receiver made entirely of glass and conductors passing through and sealed into the glass substantially as set forth and described.

10135 In testimony whereof I have hereunto set my hand this 22d day of July, 1881.

WALTER K. FREEMAN.

Witnesses—PARKER W. PAGE,
CLAYTON KNEELAND.

STATE OF NEW YORK, }
10136 *City and County of New York.* } ss.:

WALTER K. FREEMAN, the above named petitioner, being duly affirmed, deposes and says that he verily believes himself to be the original and first inventor of the Improvement in Electric Lamps described and claimed in the foregoing specification; that he does not know and does not believe that the same was ever before known or used; that the same has not been patented to him nor with his knowledge or consent in

10137

any foreign country; and that he is a citizen of the United States, and resident of Brooklyn, in the County of Kings and State of New York.

WALTER K. FREEMAN.

Subscribed and affirmed to before }
me this 22d day of July, 1881. }

CLAYTON KNEELAND,
Notary Public,
Kings Co.
[L. S.] (Acting in New York Co.) 10138

Case A. (Copied.)
Room No. 91.

DEPARTMENT OF THE INTERIOR, UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., August 20, 1881.

Electric Lamps—Filed July 25, 1881.

$\frac{38,501}{95}$ 10139

WALTER K. FREEMAN,
Care Marcellus Bailey, asso., Present.

This case has been examined.

The first claim is not patentable over King's English patent No. 10,919 of 1845, the amount of resistance of the conductor being a mere matter of degree which does not affect the question of invention.

The second and third claims are met by description in Comptes Rendus, Vol. 70, p. 606. 10140

The fourth and fifth claims do not involve invention over King's patent and the well-known mode of constructing Geissler tubes. In this connection it may be added that the question of resistance would not appear to have any relation to the manner of sealing.

The application is rejected.

G. H. WHITAKER,
Acting Examiner.

Knight—3d Asst.

10141

In the matter of the application of Walter K. Freeman for electric lamps filed July 25, 1881. Serial No. 38,501.

HON. COMMISSIONER OF PATENTS,

SIR:—In the above named matter I desire to amend by cancelling all the claims as filed and substituting therefor the following:

An electric lamp for giving light by incandescence
10142 consisting of a strip or filament of carbon of high resistance enclosed within an exhausted receiver made entirely of glass and attached to metal wires passing through and sealed into the glass as set forth.

With the above amendment the application is submitted for reconsideration. The claim has been already adjudged patentable by the office, nor have any valid references been cited which could be regarded as an anticipation.

10143 Respectfully,

PARKER W. PAGE,
Attorney for Freeman.

Copied. Room 91.

DEPARTMENT OF THE INTERIOR, UNITED STATES PATENT OFFICE,

10144 WASHINGTON, D. C., Nov. 21, 1881.

Electric lamps. 38,501. Filed July 25, 1881.

WALTER K. FREEMAN,

Care Marcellus Bailey, asso., present.

In accordance with verbal request of counsel in this case, action on the merits is postponed until further request of applicant.

K. FREEMAN, EX.

10145

Copied. Room 91.

DEPARTMENT OF THE INTERIOR, UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., Nov. 25th, 1881.

Electric lamps.
38,501.
Filed July 25, 1881.

WALTER K. FREEMAN,

Care Marcellus Bailey, asso., present.

This case has been re-examined in view of amendment of the 17th inst. 10146

The claim is rejected on Edison's patent No. 223,898 Jan. 27, 1880 (electric lights).

The word "*relatively*" in the claim if retained should be further defined, as it is not clear whether it is meant that the carbon resistance is relatively high with respect to the wires, or with respect to the carbons of former lamps.

FREEMAN,
Ex. 10147

KNIGHT.

In the matter of the application of W. K. Freeman for Patent for Improvement in Electric Lamps, filed July 25, 1881, No. 38,501.

In the above matter I here amend the specification by erasing from the claim the word "*relatively*." 10148

M. BAILEY,
Atty. for Freeman.

Applicant requests that an interference may be declared with the patent of Edison, No. 223,898, of Jan. 27, 1880, on which his present application is rejected.

10149

The affidavit required under second section of Rule 9 will be filed within a day or two.

Respectfully,

M. Bailey,

Atty. for Applnt.

10150

State of New York,
City and County of New York, } ss.:

Walter K. Freeman, being duly affirmed, deposes and says:

That he is the Walter K. Freeman by whom application was filed in the Patent Office July 25, 1881, Serial No. 38,501, for letters patent for Electric Lamps. That he conceived the invention claimed in said application,
10151 to wit, an Incandescent Lamp composed of a strip of carbon of high resistance attached to metallic wires sealed within a receiver made entirely of glass, and reduced the same to a practically operative form, before the 4th day of November, 1879; that since that time he has used all due diligence in perfecting and improving the same; that he has never abandoned the invention; and that, to the best of his knowledge and belief, it had not been in public use or on sale for more than two years prior to his making application for pa-
152 tent therefor.

Walter K. Freeman.

Affirmed to and subscribed before me this 29th day of Nov., 1881. }

James Duane Squires,

Notary Public, (245).

[L. S.] N. Y. Co.

10153

(Copied.) Room No. 91.

[INTERFERENCE.]

U. S. Patent Office, Dec. 10, 1881. Ex'r of Interferences.

Department of the Interior, United States Patent Office.

Washington, D. C., Dec. 8th, 1881.

Walter K. Freeman,

Care Marcellus Bailey, asso., Present. 10154

Please find below a copy of a communication from the Examiner concerning your application for Electric Lamps, No. 38,501, filed July 25, 1881.

Yours respectfully,

E. M. Marble,

Commissioner of Patents.

Room No. 91. All communications should be addressed to "The Commissioner of Patents, Washing- 10155
ton, D. C."

Your case above referred to is adjudged to interfere with others, hereafter specified, and the question of priority will be determined in conformity with the Rules.

The statement demanded by Rule 105 must be sealed up and filed on or before the 12th day of Jan., 1882, with the subject of the invention and name of party filing it indorsed on the envelope. The subject-
matter involved in the interference is: 10156

"An electro lamp for giving light by incandescence consisting of a strip or filament of carbon of high resistance enclosed within an exhausted receiver made entirely of glass and attached to metal wires passing through and sealed into the glass as set forth."

The only claim made by you and substantially the second claim of the interfering case.

The interfering case above referred to, is the patent

10157 ——

of T. A. Edison, Menlo Park, New Jersey, dated Nov. 4, 1879, Lemuel W. Serrell, Box. 4689, New York City, Attorney of record.

FREEMAN,
Ex.

10158 Copied.

DEPARTMENT OF THE INTERIOR, UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., March 10, 1885.

Improvement in Electric Lamp. No. 38,501. Filed July 25, 1881.

WALTER K. FREEMAN, care Marcellus Bailey, present.

In view of a newly discovered reference found in the Philosophical Transactions for 1876, p. 351 and
10159 1874, p. 513, the above named applicaton has been suspended from interference, in order that it may be rejected.

It is not deemed material that applicant claims a carbon filament in place of the platinum conductor shown in the reference, the substitution of one for the other being a matter within the skill of one well versed in matters appertaining to electric lighting, it being old in the art to use carbon conductors for incandescing lamps, as shown in King's English patent
10160 No. 10,919, 1845, and Konn's Eng. patent No. 3,809, of 1872.

The publication above referred to may be found in the Patent Office Library.

C. J. KINTER,
Ex.

—— 10161

In the matter of the application of Walter K. Freeman, Impt. in Electric Lamps, filed July 25, 1881, Serial No. 38,501.

To the Commissioners of Patents:

Sir:—

In this matter we respectfully request re-consideration of the official action of March 10, 1885, respecting said application upon newly discovered references.

Respectfully, 10162

MARCELLUS BAILEY,
for Applnt.

Copied.

DEPARTMENT OF THE INTERIOR, UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., March 18th, 1887.

Electric Lamps, No. 38,501, filed July 25, 1881. 10163

WALTER K. FREEMAN, care Marcellus Bailey, City.

Please find below a communication from the Examiner in charge of the application above noted.

M. V. MONTGOMERY,
Commissioner of Patents.

Room 91. All communications should be addressed 10164
to "The Commissioner of Patents, Washington, D. C."

In accordance with applicant's request for a consideration of the official action of March 10, 1885, a re-examination has been made, and said action is now repeated, as no reason appears why it should be receded from.

C. J. KINTER,
Ex.

COWLES.

10165

Serial No. 38,501. Ex'r Book No.

95 "A."

1881. Div. 16.

Patent No.

Walter K. Freeman,

10166 Assor. to Charles R. Flint, of New York, N. Y.

Of Brooklyn.
County of Kings.
State of New York.
Invention.

ELECTRIC LAMPS.

Parts of application filed.

10167 Petition. July 25, 1881.
Affidavit. " " "
Specification. " " "
Drawing. " " "
Model.
Specimen.
First fee cash $15, July 25, 1881.
" " Cert.
Application filed complete.
Examined.
Countersigned.
Notice of allowance. For Commissioner.

10168 Final fee cash.
" " Cert.
Patented.

Att'y or P. O. Address, Parker W. Page, N. Y. City. Marcellus Bailey, Asso. Present.

1881. 10169

CONTENTS:

Application	papers.
Aug. 20, 1881	Rejected.
Nov. 17, 1881	Amdt. "C."
Nov. 21, 1881	Letter.
Nov. 25, 1881	Rejected.
Nov. 29, 1881	Amdt. 10170
Nov. 30, 1881	Affidavit.
Dec. 8, 1881 X 223,898.	
Mar. 10, 1885.	Letter.
Mar. 2, 1887	Request for Recon.

Rejected March 18, 1887.

TITLE:

Improvement in 10171

36. Electricity, Electric Lights.

10173

Defendant's Exhibit Motion for Production of Edison and others for Cross-examination.

UNITED STATES CIRCUIT COURT,

FOR THE SOUTHERN DISTRICT OF NEW YORK.

10174 THE EDISON ELECTRIC LIGHT COMPANY,
Complainant,
against
THE UNITED STATES ELECTRIC LIGHTING COMPANY,
Defendant.

In Equity, No. 3,445.

Please take notice that on Friday, the 24th day of
10175 April, 1890, at 11 o'clock A. M., or as soon thereafter as counsel can be heard, we shall move the U. S. Circuit Court for the Southern District of New York, at the U. S. Court House, in the City of New York, upon the affidavits hereto annexed, of L. E. Curtis, S. A. Duncan, and Amos Broadnax, and upon all the pleadings, record and proceedings in the cause, for an order directing the complainant to produce for cross-examination by defendant's counsel the witnesses Thomas A. Edison, Charles Batchelor and Francis R. Upton,
10176 and each of them, and granting a stay of proceedings on the part of the complainant until such order be complied with, and for such other and further relief in the premises as to the Court may seem meet and just.

April 24, 1890.

DUNCAN, CURTIS & PAGE,
Solicitors for Defendant.

Messrs. EATON & LEWIS,
Solicitors for Complainant.

10177

UNITED STATES CIRCUIT COURT.

SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT COMPANY,
Complainant,
against
THE UNITED STATES ELECTRIC LIGHTING COMPANY,
Defendant.

In Equity, No. 3,445. 10178

And now comes the defendant herein, by its solicitors, Duncan, Curtis & Page, and moves the Honorable Court, upon the pleadings, proceedings and the whole 10179
record herein, and upon the affidavits of L. E. Curtis, S. A. Duncan, and Amos Broadnax, hereto annexed, for an order directing the complainant herein to produce for cross-examination by counsel for defendant, the witnesses Thomas A. Edison, Charles Batchelor and Francis R. Upton, and each of them, whose depositions taken in the suit of the Consolidated Electric Light Co. vs. the McKeesport Light Co. have been offered in evidence herein by the complainant, and that further proceedings on the part of the complainant be stayed until such order be complied with, and 10180
for such other and further relief in the premises as to this Honorable Court may seem meet and just.

EDISON ELECTRIC LIGHT CO.
vs.
U. S. ELECTRIC LIGHTING CO.

10182

WALLACE, *J.:*

In disposing of this motion I have not deemed it proper to investigate any question of veracity which depends upon the oral communications between counsel. The stipulation at page 1,153 of defendant's record interprets itself with all necessary precision. The counsel for the defendant have doubtless acted on an erroneous understanding of their rights, and it is just that they should have an opportunity to produce and
10183 examine the witnesses whom they seek to compel the complainant to produce. The time for the defendant to close its proofs will therefore be extended for such a reasonable period as will permit the examination of these witnesses.

[Endorsed: Edison Company v. U. S. Lighting Company. Mem. Wallace, *J.* U. S. Circuit Court. Filed May 19, 1890. John A. Shields, Clerk.]

10184 JOHN A. SHIELDS,
Clerk.

[Seal].

E. C. M. A copy.

10185

At a Stated Term of the Circuit Court of the United States, in and for the Southern District of New York, held at the Court Rooms thereof in the City of New York, on the 29th day of May, 1890.

Present: HON. WILLIAM J. WALLACE, 10186
Circuit Judge.

THE EDISON ELECTRIC LIGHT COMPANY,
Complainant,
against
THE UNITED STATES ELECTRIC LIGHTING COMPANY,
Defendant.
In Equity, No. 3,445. 10187

The defendant having moved upon affidavits for an order herein to compel the complainant to produce as witnesses, and for further cross-examination, Thomas A. Edison, Charles Batchelor and Francis R. Upton, 10188
and in default of its so doing that all proceedings of the complainant herein might be stayed; and said motion having been brought on for argument, and Edmund Wetmore, Esq., and Samuel A. Duncan, Esq., having been heard in support thereof, and Grosvenor Lowrey, Esq., in opposition thereto; and due delib-

10189

eration having been had, it is by the Court now here

Ordered,

1. That the said motion be and the same is hereby denied except as follows:

10190 2. That the time for the defendant to take such further proofs herein as may be advised is hereby extended to and including the 20th day of June, 1890.

3. That the complainant have twenty days after the closing of the defendant's proofs hereunder to put in its rebutting evidence.

W. J. WALLACE.

10193

UNITED STATES CIRCUIT COURT.

SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT COMPANY
against
THE UNITED STATES ELECTRIC LIGHTING COMPANY.
} In Equity. No. 3445.

10194

Testimony taken pursuant to the order of the Court of May 29, 1890, before Samuel M. Hitchcock, Esq., a standing Examiner of the Court, under notice duly served by counsel for defendant upon complainant's counsel.

June 10, 1890. 10195

Met on June 10, 1890, at Orange, New Jersey, by agreement of counsel, instead of at No. 120 Broadway, in the city of New York, this being done to suit the convenience of complainant.

Present—For Complainant: CLARENCE A. SEWARD,
GROSVENOR P. LOWREY,
RICHARD N. DYER,
For Defendant: S. A. DUNCAN.

10196

THOMAS A. EDISON, being subpœnaed by the defendant, is called.

It is agreed between counsel, the Examiner

10197 not being present, that the testimony may be taken stenographically and that the witness may be sworn to his testimony at some future day.

Direct Examination by S. A. Duncan, Esq.

10198 1 Q. Are you the patentee of Letters Patent, No. 223,898?

A. Yes.

2 Q. Did you make an affidavit in the proceedings before the Canadian Patent Office, brought by the Royal Electric Company against the Edison Electric Light Company in the year 1888?

Objected to as incompetent.

A. Yes.

10199 3 Q. Were the statements made by you in that affidavit true?

A. Yes.

4 Q. Examine the paper now shown you and state whether that is a correct copy of your said affidavit?

A. I have no reason to doubt that it is a correct copy.

5 Q. Please examine the said paper and say whether the statements therein contained are true?

A. That is my affidavit; if a true copy, the state-
10200 ments are true?

6 Q. Please examine the paper with sufficient care to determine whether the statements contained in it are true?

A. I have examined the paper and the statements are true?

Defendant's counsel offers the paper in evidence, the same to be marked "Defendant's Exhibit Edison's Canadian Affidavit."

7 Q. How long have you practiced the method of treating carbons electrically after they leave the furnace, and before sealing up the globe, as described in your Canadian affidavit? 10201

A. I think I described in a patent applied for some time in 1879, the heating of carbon in the lamp by the current. I have used it since then at different times, and always in the manufacture of our regular lamps.

8 Q. Do you remember whether the lamps that were placed on the steamship Columbia had their carbons 10202
treated electrically?

A. The lamps on the steamer Columbia had their carbons treated by a current before they were sealed.

9 Q. Did you at that time regard that as an important step in the manufacture of the carbons?

A. It was a necessary step to obtain a vacuum.

10 Q. Why so?

A. Because the ordinary heat of carbonization is not quite sufficient to decompose entirely the carbonaceous compounds from which the carbon was made. 10203

11 Q. When you say that the electrical heating was a necessary step, do you mean that a commercial lamp could not be made without that?

A. We always did heat them. I suppose conditions could be found whereby it would not be absolutely essential to heat them to make a commercial lamp, although it would be rather difficult, as a commercial lamp in 1880 was not a perfectly commercial lamp in 1881, and so on. The standard of a commercial lamp has been raised continuously since the date of my patent, by my own free will, and also by the necessities 10204
of competition.

12 Q. Were the carbons of the very first lamps made by you in 1879 in which you used an all-glass globe, treated electrically before the sealing up of the globe?

A. Yes, sir.

13 Q. I suppose you have made some lamps in which

10205
a carbon filament not treated electrically was used in an all-glass globe, have you not ?

A. Yes.

14 Q. When ?

A. I remember having tried some in 1882, I think.

15 Q. With what result as to durability and otherwise ?

10206 A, My impression is that they lasted about half the length of time that the regular lamps we were making at the time lasted.

16 Q. Is that the best result you ever got by the use of carbons not treated electrically ?

A. I do not call to mind the exact results. I could, however, probably find records of these results. I could have the experiment tried if you desire, now.

17 Q. In your Canadian affidavit you say that "at times we have entirely lost the art of carbonization." What did you do at such times in order to carry on the
10207 manufacture of your lamps ?

A. What I mean in the affidavit by the "loss of the art of carbonization" was the loss of the art of producing the lamps as high in efficiency and life as we had produced them. There were fierce struggles in competition and the man who made the greatest number of lamps for a horse power stood the best show of getting the business. We had worked the art up to the highest point and we would keep it there for awhile, but for some unknown reason the lamps would depre-
10208 ciate, but they would never fall so low as to make much material difference, but still sufficient to produce a loss of business in competition.

18 Q. Then I understand you to indicate that the expression that you "lost the art of carbonization" is a figure of speech and not a literal fact ?

A. Of course I did not mean to say that we could not carbonize at all, but it was a loss of the art of carbonizing as well as we had been carbonizing.

19. Q. Did you at such times resort to the same expe-

10209
dient that you say Mr. Hippel and Mr. Batchelor resorted to in Berlin and in Paris when they lost the art of carbonization there, or, if you please, when they found themselves unable in those cities to practice the art in the same way in which you had taught it to them here in New Jersey ?

A. They did not lose the art of making lamps. They lost the art of carbonizing and making lamps equal to those made by us and by some of their competitors. They resorted to the hydro-carbon process. I did not 10210
resort to the hydro-carbon process, because it was patented in this country, and I do not steal patents.

20 Q. In your patent No. 223,898 occurs a paragraph beginning as follows: "If the carbon thread is liable to be distorted during carbonization, it is to be coiled between a helix of copper wire," etc. Will you kindly explain how at the time of application for said patent, or at the time when the said patent was granted, you proposed to manipulate the copper wire in order to effect the object set forth in that para- 10211
graph ?

A. I accomplished the object as described in the paragraph itself.

21 Q. Did you make use of a mandril in connection with the copper wire ?

A. I do not remember. I suppose we did; that would be a necessary consequence of coiling anything in a spiral.

22 Q. Then did you leave the copper wire and the carbon filament on that mandril during the process of 10212
carbonization ?

A. No, the tar filament used to dry pretty hard after awhile; the vapors from the tar would cause the tar to harden, and that would harden the filament, and it would not require any mandril to support it after a little while.

23 Q. Was this your process, then, that you wound

10213 the filament and the copper wire on a mandril and let the filament dry, and then withdrew the mandril before carbonization?

A. If I remember right, that is the way we did it.

24. Q. You actually made the carbon filament that way, did you?

A. Yes, sir.

25 Q. How were they?

A. I would have to look up my testimony to see.
10214 It is so many years ago that I would have to refresh my memory.

26 Q. Do you recall any other way of accomplishing the object set forth in the paragraph in question except what I have already indicated. I refer to the paragraph of your patent relating to the coiling of the carbon burner in conjunction with copper wire?

A. I don't remember now. The patent gives all the information that is required. It seems to me that the patent is sufficient and can stand on its own bottom.

10215 27 Q. If, then, you were working under the patent alone, how would you manipulate the carbon and the copper wire in order to secure a coiled carbonized filament?

A. I would do it in the way described in the patent.

28 Q. Would you make use of a mandril?

A. Yes, sir.

29 Q. Would you withdraw the mandril before carbonization.

A. Yes, sir.

10216 30 Q. Are those those two steps described in the Patent?

A. No, sir; they are self-evident. A man is told to wind a spiral—the human mind can conceive of no other way to wind it except on a mandril.

31 Q. Do you remember whether you ever filed an application for a patent for doing that thing?

A. Doing what thing?

32 Q. Winding a carbon filament and a copper wire

or ribbon on a mandril for the purpose of producing carbon to be used in incandescent lamps? 10217

A. I might have shown it in a patent; I do not think I tried to claim making a spiral on a mandril.

33 Q. Did you ever file a caveat for doing that thing on the theory that you had made an invention?

A. I don't remember any such caveat.

34 Q. Examine the document now shown you, which purports to be a caveat filed by you in the Patent Office December 22d, 1879, and state whether you ever filed such a caveat? 10218

A. I believe I did.

Defendants' counsel offers the document last referred to in evidence, and the same is marked Defendants' Exhibit Edison Caveat, December 22d, 1879.

35 Q. If a carbon filament be wound on a mandril between the coils of a copper wire, and the mandril be withdrawn, would the carbon and the copper wire fall apart from each other? 10219

A. It is according to how the ends are secured or what means are taken to prevent them from falling apart.

36 Q. Then they would fall apart unless some special means was adopted to prevent it after the withdrawal of the mandril, would they not?

A. I don't just remember now; I will go and try the experiment if you desire. (Mr. Edison, after a few minutes, returning, says): I have tried the experiment; if the job was done well the spiral would stay in position but if wound loose it would drop down, but the two spirals would not separate from each other. 10220

37 Q. On winding a carbon filament and a copper wire onto a mandril for the purpose of carbonization, why is it necessary to withdraw the mandril before introducing the carbon into the furnace?

10221 A. I don't know as it is; I don't remember now; I have an impression that the ends draw up.

38 Q. Do you remember how it was with the first tar-putty spiral burners that you made; did you use a mandril or not, and if you used a mandril for the winding, did you withdraw the mandril before carbonization?

A. I don't remember just now. I remember using a peculiar spiral made by a machine that we had got up
10222 for making a peculiar platinum spiral, and I remember that after we coiled the carbon in this peculiar flat spiral we compressed it and gave another shape to the carbon and thus caused the carbon to stick to the copper. I don't just remember how this came out.

39 Q. How many tar-putty burners had you made before you applied for patent No. 223,898?

A. I don't remember; I would have to look up some of my old data to refresh my memory.

40 Q. The number was very small, was it not?

10223 A. Yes, there were not many.

41 Q. Had you made more paper carbons then than you had tar-putty carbons?

A. At the date of the application for the patent and a little before, after having found out that these fine filaments did not give the phenomena of disintegrating under the conditions of high vacuum, we started in to try a great many things—a great many different kinds of material—to see which was the most commercial; so we did not stop to make a great number of any partic-
10224 ular kind.

42 Q. The question is whether, at the date of the application for your patent (which was November 4, 1879) you had made more paper carbons for incandescent lamps than you had made of tar-putty carbon?

A. I am not sure without looking up the record. In those days two or three of a kind after testing would be sufficient to give us a rough idea of its value, and permit us to go on to other things. There was an

enormous field which we hoped quickly to get over so as 10225
to get a commercial lamp. I should have to look up my old records to refresh my memory on that point as to the number of paper carbons and the number of tar lampblack carbons.

43 Q. Do you remember which kind of carbon you first put into a highly exhausted all-glass globe, paper or tar-putty?

A. It was a thread carbon, and if I remember right it was on the 21st of October, 1879, that broad sun- 10226
light was thrown on this business of incandescent lighting.

44 Q. What do you mean by that expression?

A. I mean to say that I discovered the fact that carbon would stand high temperatures even when very attenuated, in a high vacuum, without the phenomena of disintegration which took place in all the previous attempts that I know of, when trying to use carbon to make an incandescent lamp.

45 Q. Was that discovery the result of that experi- 10227
ment in which you used a thread in a highly exhausted all glass globe?

A. Yes, sir; it was in that particular lamp that I discovered this all-important fact that something which was expected to take place did not take place, and this discovery permitted the use of fine filaments and carbon of high specific resistance, and made incandescent lighting, as we know it, commercially practicable.

46 Q. This discovery you made when?

A. That experiment was made on October 21st, 10228
1879, if my memory don't fail me. It is stated in the patent that I had made such a discovery. It was not an invention, it was a discovery, to my mind.

47 Q. What did you expect would take place that did not take place?

A. I expected that there would be a disintegration of the carbon to a certain extent. How much, was the object of the experiment.

10229 48 Q. There was some disintegration, was there not?

A. No, sir; none that we noticed, up to the time that we broke the lamp by bringing it up to an enormous temperature, where we expected it to break.

49 Q. In fact, there is a disintegration going on in the carbon of all the modern incandescent lamps.

A. That disintegration in good lamps was not noticed for some time, because it takes, in a well made
10230 lamp, several hundred hours to show disintegration by a slight blackening of the globe; but as that takes two or three months to find that out, we could not have known it at the time. However, the disintegration has never been of any moment.

50 Q. This, I suppose, is the real discovery which you profess to have made by that experiment of October 21st, 1879, namely, that the carbon did not disintegrate *as rapidly* as you supposed it would. Am I right in that statement?

10231 A. The discovery I made was that a fine filament of carbon, under the conditions I had, did not disintegrate to any extent. That was the discovery as set forth in my patent, but the patent has also in addition to discovery some invention as well as discovery; in other words, it required invention to carry out the discovery which I made.

51 Q. You made your "invention" before you made the "discovery" of course?

A. That question is a little too deep for me. I
10232 think I will let the Judge decide that.

52 Q. Did you expect before you tried that experiment of October 21st, 1879, that the carbon would go to pieces under the experiment?

A. I expected that it would wear away gradually, but hoped that the wearing away would not be so great under the conditions I had as to prevent its use at the temperature which I proposed to run it at.

53 Q. Did you *expect* that the carbon would wear

away so rapidly that the lamp would not be a serviceable, practical lamp? 10233

A. In trying an experiment I always expect something of advantage. I thought in this case that the wearing away would not be so great as to prevent the use of the lamp for commercial lighting, but I did not expect that it would not wear away at all.

54 Q. Now what was it that occurred in that experiment that you did not expect?

A. I did not expect that it would run at the candle 10234
power that I put it at without showing signs of disintegration.

55 Q. Then this discovery that you made at this time was nothing more nor less than this—that the lamp worked somewhat better than you expected it to work; was there any other discovery than that?

A. Worked enormously better; there was a gigantic difference between a little fine filament wearing away and not wearing away, because wearing away with such a fine filament in a very minute degree would prevent 10235
long life. The fact that it did not wear away was a great surprise, and I have called this a discovery, as stated in my patent.

56 Q. Then really what you expected in that experiment was that the so-called filament would wear away, and the discovery and surprise were that it did not wear away; is that a correct statement?

A. Yes, I expected that it would wear away, and the discovery I made was that it did not wear away under the conditions I had put in the lamp. 10236

56 Q. Of course you mean now to say that it did not wear away *appreciably* in the time consumed in the experiment?

A. We could discover no wearing away; we only discovered that they did almost inappreciably wear away after we had made a great number of lamps and set them up and waited a long while to see.

57 Q. What kind of carbon was used in the second

10237
lamp which you made using a highly exhausted all-glass globe, was it paper or tar putty?

A. I don't remember; I would have to refresh my memory by looking at the notes.

58 Q. Prior to the time when you applied for this patent, what other materials had you used for manufacturing the carbon besides thread, paper and tar putty?

A. I remembered vulcanized fibre, I think some
10238 fibres of manilla. I would have to look at my notes to see what we did use.

59 Q. Of these various substances, which gave the best results at that time?

A. My impression is that the paper gave the best.

60 Q. Have you any record of the actual performance of the tar-putty lamp?

A. I think we have. My counsel will probably be able to produce such records.

10239 Counsel for complainant states that they are not in possession of any records which would fulfill the conditions of the question as they understand it.

61 Q. In view of this statement of your counsel, do you still say that you think you have records that will show the actual performance of the tar-putty lamps?

A. If they have not got any records, then I haven't.

62 Q. You have records showing the actual perform-
10240 ance of the lamps in which thread carbons and paper carbons were used, have you not?

A. Yes.

63 Q. And did you keep records showing the performance of the tar-putty lamp?

A. I do not remember; I think we did.

64 Q. What probably has become of those records?

A. I don't know. We saved all the records we

10241
could. I have several hundred books all of which are numbered.

65 Q. Was there a special book devoted to tar-putty lamps?

A. I do not remember that; I think not.

66 Q. Was the record of those lamps mixed in with the record of the paper and thread lamps?

A. I should think they ought to be.

67 Q. Then why is not there a record of the perform-
ance of those lamps in the same books, which I assume 10242
are now in your possession or the possession of your counsel, which contain the record of the paper lamps?

A. I do not know why. It is probable that, on discovering about the thread, we followed up that class of carbon produced from carbonizing substances which, on decomposition, produced carbon. The patent, necessarily, would more fully set out descriptively the tar-putty lamps, as there was more manipulation in this character of lamp.

68 Q. Then, as I understand you, you have no pres- 10243
ent means of determining how many tar-putty lamps you ever made, or of determining what their actual performance was when put to the test?

A. If my counsel has not them, I am certain that I have not. I believe that they have hunted up all the records that could be found.

69 Q. You have spoken of the manipulation necessary to produce tar-putty filaments; did you find difficulty practically in producing such filaments?

A. The patent, of course, has to describe how such
filaments are made, because they were an artificial pro- 10244
duct. Such description would not apply to paper because paper we already find in the art, and it would be unnecessary to describe how to make paper. There was no difficulty in producing tar-putty filaments. I would be very happy to produce them before the Judge in court.

70 Q. Can you fix the date when you devised that

10245
method of manipulating the tar-putty filaments for the purpose of carbonization which is described in your caveat of December 22d, 1879?

A. A spiral carbon produced as described in the caveat, is a special case of a peculiar spiral made in a peculiar way, and manipulated in a peculiar manner. The patent in controversy does not have this
10246 spiral made in a peculiar way, but it simply says a spiral. I do not remember how I made that exact thing. I would have to refer to my notes.

71 Q. In answer to question 412 of your deposition in the McKeesport suit (transferred into this suit) you seem to lay much emphasis upon the necessity of putting the carbon, if it be in filamentary form, under strain and pressure during the process of carbonization. When, if you remember, did you discover the necessity for putting the filament under strain and pressure at the time of carbonization?

10247 A. I do not exactly remember when it was. I have used materials which, on kneading, were carbonized and left charcoal, and found, without they were strained in some way, they would go in all kinds of direction and be very much distorted. The tar putty distorts very little; it is those things like cellulose that are very liable to distortion.

72 Q. How is it with paper?

A. That distorts considerably.

73 Q. And bamboo?

10248 A. That does not distort quite so much.

74 Q. Practically do you put strain and pressure on the bamboo when you carbonize it?

A. We used to, but we do not do it now.

75 Q. You are not making paper lamps now, are you?

A. No, I believe not.

76 Q. When you were making paper carbons, was it your practice to put the paper under strain and pressure?

A. Yes; we used to lay something on top of it to keep it from curling up. 10249

77 Q. And was that the case from the very start?

A. I think we always used something to prevent distortion.

78 Q. Take the first paper carbon and the first thread carbon that you made, what were the methods that you adopted to prevent this distortion?

A. My impression was that the first one was packed in carbon dust. 10250

79 Q. The very first one?

A. I think so.

80 Q. You refer now to the one made of thread or the one made of paper?

A. I refer to the one made of paper; I do not remember exactly how the thread one was carbonized. I think the thread did not distort as it was so very flexible.

81 Q. If you were making thread carbons to-day, would you make them without using some method of 10251
strain and pressure to prevent distortion?

A. My impression is that thread stays just where it is put; it don't seem to want to curl up.

82 Q. You knew as early as 1876 that it was essential, in order to prevent paper from becoming distorted during the process of carbonization, that it should be put under strain and pressure?

A. Yes, I know as early if not earlier than that, that to get it in the shape I wanted it, something had
to be done to prevent it from distorting, and it was 10252
put under strain and pressure.

83 Q. In your carbonizing operations in 1876, what means did you adopt to put strain upon the paper to prevent its distortion?

A. I think we used a weight on top of the paper.

84 Q. "Strain," then, means the same as "pressure" in that connection, does it?

A. Well, the weight would produce pressure, then

10253 the paper in the act of carbonizing diminishes in size very much, and that would produce strain, which would tend to keep it straight.

85 Q. Then, when in your testimony you have spoken of "strain" and "pressure" as important in carbonizing filaments for incandescent lamps, you have referred to strain which arises from pressure, have you?

A. I have used it, perhaps, in that sense, although I remember of causing carbon to draw up little weights
10254 in 1879. I cannot exactly say in what sense I used it.

86 Q. Then you had devised methods of putting strain and pressure upon carbons during the process of preparing them for incandescent lamps as early as the year 1879, had you?

A. Yes, we generally used strain and pressure, although if the carbons were confined within a limited space they would be all right, except that they would present somewhat of an undulating appearance, something like the tamadine lamps of Mr. Weston. Car-
10255 bonizing under strain and pressure tends to make the filaments look much better and make them more even and alike. It is not absolutely essential when they are confined to a space which will prevent them from a too great distortion.

87 Q. How early in your experiments with carbon lamps did you make use of clamps as a method of uniting the carbon burner to the leading-in wires?

A. I know we used them in December, 1879.

88 Q. Please examine your answer to cross-question
10256 203 in the Interference Proceedings with Sawyer and Man, and state whether you did not make use of clamps before December, 1879?

A. I don't give date in the statement of cross-question 203; it might have been in November, 1879.

89 Q. In that answer were you not referring to the first paper carbon lamp that you made?

A. No, the first paper carbon lamp I made was made out of what is called vulcanized fibre.

10257

90 Q. Was the carbon of the lamp which is referred to in your answer to cross-question 203 of the Sawyer and Man interference united to the leading-in wires by means of clamps?

A. Yes, I think it was.

91 Q. Go back to cross-question 197 of the same deposition and say whether the lamp referred to in cross-question 203 was not made as early as October, 1879?

A. It may have been as early as October; my im- 10258
pression is that it was sometime in November.

92 Q. Does not the context show that it must have been in October?

A. No; I stated in answer to cross-question 197 that I thought it was made in October, 1879; I think it was the last of October or about the 1st of November. It was made then as near as I can remember just now.

93 Q. Why were the ends of the paper carbon thickened?

A. So that there would not be so much heating 10259
down there, and to give us a better chance for clamping.

94 Q. Was it essential in using clamps that the ends of the carbon be thickened?

A. Yes, I think it is necessary.

95 Q. You knew that at that time?

A. Yes, I think we did.

96 Q. Have you no means of telling the exact date when you first made a paper carbon with thickened ends? 10260

A. It may possibly be somewhere in this mass of testimony that I have given; it is in some of the exhibits in the case. My counsel probably could find it. I suppose you refer to a thickened end made with a carbon and not to a carbon having a thickened end by adding some carbonaceous material to it.

97 Q. I refer to a carbon, having its end thickened

10261

or broadened for the purpose of receiving a mechanical clamp?

A. Do you mean thickened or broadened by adding some carbonaceous matter to it, or paper originally thickened or broadened, which after carbonization produce a thickened and broadened end?

98 Q. My question will be broad enough to include both methods of thickening, or either method of thickening?

10262 A. Then around about October 22 or 23 we made a paper carbon that where it come in contact with the clamps had thickened ends; but how it was thickened, whether it was originally a part of the paper or whether it was secured by a carbonaceous paste, I do not remember just now.

99 Q. But it was thickened for the purpose of fitting it to receive clamps, was it?

A. It was thickened for the purpose of making a contact with the leading-in wires.

10263 100 Q. By means of clamps?

A. I don't think the first carbon lamp of paper had clamps.

101 Q. I am not speaking now of the first lamp having a paper carbon, but of the first lamp having a paper carbon whose ends were thickened? Now in that lamp were the ends thickened for the purpose of giving better contact with the clamps that formed the union between the carbon and the leading-in wires?

10264 A. The lamps made around about the first of November were made out of paper and the ends of the paper were broader than the loop, and on carbonization left broad ends to the arch, and these broad ends were for the purpose of diminishing the temperature so that it would make better contact with the platinum clamps which we used.

102 Q. In practice after that time, when you were making lamps commercially, how important did you

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find it that the ends of the carbon should be thickened or broadened?

A. Well, we made some paper carbon lamps around in November that did not have any thickened ends, but we plated the ends with copper and then put them into clamps. These worked very well. It is important that the contact between the platinum wire and the carbon should be made good, and it is in the act of making it good that it is necessary to have a larger mass of matter at that point so that the whole is not 10266
brought up to a temperature which would make bad contact with the platinum.

103 Q. In your answer to question 33 in the Sawyer and Man interference, referring to some of the early incandescent lamps made by you, you say:

"But the lamps, in addition to the fact that they lasted for a long time, had other characteristics without which, even with their long life, they would not have been available for competing with gas. These important 10267
characteristics were that they were of high resistance, of small radiating surface, and hence economical for the reason that smaller conducting wires could be used for conveying the current, as, owing to the high resistance of the lamp, weak currents only were necessary and sufficient energy to produce the result was forced through the wire and lamps by increasing the electric pressure or electro-motive force. If lamps of low resistance were placed in multiple arc in a single circuit, the aggregate resistance of all the lamps would be very low and conductors of cor- 10268
responding large dimensions would have to be used, otherwise a great loss of current in the form of heat would take place on the conductor."

When you so testified, did you consider that you were the discoverer of the principle in electrical engineering that by increasing the resistance of a trans-

10269 lating device which was to be used in multiple arc, you could effect an economy in the conductor?

> Objected to on the ground that it is immaterial what may have been Mr. Edison's opinion at the time he made his deposition as to any bearing which it has upon the issue raised upon this point, and, second, upon the
> 10270 ground that in view of the peculiar relation of the witness to the controversy we think it is the duty of counsel in putting any questions which may draw from him expert opinions, to notify him that he is now being examined as an expert and that this is one of those. He may not be willing to be examined as an expert and would not want to give such an opinion unless he was so advised.

A. I think I was the first one to appreciate that
10271 principle so highly as to stick to it until I had produced a means whereby it could be utilized.

104 Q. Then, in giving the testimony quoted in the last question, in the year 1881, you did not regard yourself as the discoverer of that principle or law of electrical distribution, did you?

A. I did not discover Ohm's law, no. I only appreciated one of the applications of that law.

105 Q. In that appreciation of the application of Ohm's law, did you consider that you had discovered
10272 any new principle whatever in regard to electric distribution?

A. I do not understand what you mean by electrical distribution. I am not well versed in the metaphysics of words and I do not like to answer that question, because I think it may be too deep for me.

106 Q. You recognize the fact, do you not, that in this art of incandescent lighting there is a certain practical relation existing between the size and pro-

portions of the incandescent burner and the character 10273
of the conductors employed to carry the current to the lamp?

A. That depends upon what system you use.

107 Q. I assume, and ought to have said in my question, that the lamps are to be arranged in multiple arc.

A. There is such a relation.

108 Q. Do you consider yourself the discoverer of that relation? 10274

A. I do not consider myself the discoverer of Ohm's law, and Ohm's law will explain all things that have been done, and it will probably explain everything that will be done in the next thousand years in electricity.

109 Q. Is that the best answer that you can make to the question?

A. I don't like to be drawn in as an expert; I am not an expert on the question of words. I will answer questions of fact, but I do not like to expert.

110 Q. It does not occur to me that I am examining 10275
you as an expert on this matter; I simply asked you whether you considered that you are the person who discovered the relation that exists between the size and proportions of the burner of an incandescent lamp and the character of the conductors employed to convey the current to such lamp when the lamp is being used in multiple arc?

A. I do not know whether I am or not in relation to an incandescent lamp. Ohm's law did not mention in-
candescent lamps. It is a broad general law. I think 10276
I have already stated a sufficient answer. There were two ways of doing incandescent lighting which were known to all men. One was by series, one was by multiple arc. Everyone seemed to be working on series. I concluded that that was the wrong principle and I concluded that the multiple arc was the best principle, and I so appreciated the fact that that was the best princi-

10277 ple of the two that I kept at it until I had produced a lamp which was of suitable form for work in multiple arc. I did not discover the law of Ohm or its application to that particular system, but there were two systems open to all men, and I chose the multiple arc system and I worked at it until I got the conditions which permitted utilizing that particular system.

111 Q. Didn't you know, as matter of logical inference from Ohm's law, which I assume you were famil-
10278 iar with before you began experimenting on electric lighting, that if you adopted the multiple arc system for your incandescent lamps you would have to make the resistance of the individual lamps higher than if you adopted the series system?

A. I don't think that Ohm's law took into consideration the prices of copper. I think it is simply a bare law, and as far as Ohm's law is concerned, they would work in multiple arc and in series just the same, but there was a commercial question outside of the broad
10279 principle of Ohm's law which had to be taken into consideration.

112 Q. By that I understand you to intimate that if you could have afforded to employ enough copper you could have used the same lamps in multiple arc that you might have used with a smaller amount of copper in series?

A. Well, that is a metaphysical question.

113 Q. I will put this question, then: Didn't you know, as a matter of inference from Ohm's law, at the
10280 time when you began your experimentation with incandescent lamps, that with a given size of conductor it would be necessary to give the individual lamps a higher resistance if they were to be used in multiple arc than would be necessary if they were to be used in series?

A. It is not necessary in applying Ohm's law at all, but when you bring in the commercial element in con-

nection with that law, then it is; the fact of the matter is that at the time I experimented on the incandescent lamp I did not understand Ohm's law. 10281

114 Q. Do you mean that you did not know the formula of Ohm's law at that time?

A. No, sir, I did not know it.

115 Q. When did you first get knowledge of Ohm's law?

A. It may seem strange for me to state that I do not really understand Ohm's law to-day. 10282

116 Q. I do not now ask you whether you understand Ohm's law, but when did you first know of this law?

A. I have heard of Ohm's law for the last twenty years.

117 Q. What do you mean by saying that you did not know Ohm's law at the time you began experimenting with incandescent lamps?

A. I mean to say that I did not understand Ohm's law. I do not understand Ohm's law now; and more- 10283
over I do not want to understand Ohm's law; it would prevent me from experimenting.

118 Q. Why would a knowledge of Ohm's law prevent you from experimenting?

A. Because I would try to figure it out mathematically, and I have had a great many mathematicians employed by me for the last ten years, and they have all been dead failures.

119 Q. Does that include Mr. Upton?

A. Yes, sir, in his mathematical capacity. 10284

120 Q. Leaving out of account, now, all reference to Ohm's law, which so seems to disturb your peace of mind, please state whether, when you began experimenting with incandescent lamps, you did not know from your general knowledge of the laws of electricity, that, if your lamp was to be arranged in multiple arc, the burner would have to be made of higher resistance than if the lamp were in series, provided the conductor

10285

conveying the current to the lamp was the same in the two systems. I assume, of course, that the candle power of the lamp is the same, whether used in multiple or in series?

A. That is metaphysical. You do not state any length of such conductor.

121 Q. Is it a fact that an incandescent lamp of a given candle power designed for use in multiple arc, should have higher resistance than a lamp of the same
10286 candle power designed for use in series?

A It should have; the lamp in series should be of low resistance, although it could be made of high resistance, although it is not so commercially available.

122 Q. Why should this difference between the two classes of lamps exist?

A. Because they work on different principles.

123 Q. How so?

A. In one case it is the same current with a varying pressure; in the other case it is a constant pressure
10287 and a varying current.

124 Q. Please explain why that requires that lamps shall have different resistances?

A. They don't require to be of different resistances.

125 Q. I thought you just said that the lamps made for multiple-arc service should have a higher resistance than for series.

A. I don't say they have to; I say it is better.

126 Q. Please explain why.

A. I did not say they had to be; it is not absolutely
10288 compulsory to carry out that. It is only compulsory, I should say, commercially speaking.

128 Q. Please explain why, commercially speaking, this difference in the resistance of the two classes of lamps should be made?

A. That is an expert question. It has already been gone over by a number of experts, and I do not like to answer it.

10289

128 Q. Do you mean by a number of experts in this case?

A. No; the testimony that seems to be in this case.

129 Q. What experts in this case have gone over that question?

A. I do not remember now, but I remember reading over a great deal of testimony and seeing experts describe the difference between multiple arc and series. One more explanation from me I do not think would
add anything to it, and I do not like to go into experting. 10290

130 Q. Do you, then, decline to answer the question?

A. I do not like to decline to answer it, still I would prefer very much that you would not ask me to go into experting.

131 Q. What I really wish to know, Mr. Edison, is this: Whether, at the time when you began experimenting with incandescent lamps, the well-known laws of elec-
tricity did not teach you that it would be a matter of 10291
economy to make the burner of the lamp of higher resistance, if the lamp were to be used in multiple arc, than its resistance would be if the lamp were to be used in series?

A. That is fully set forth in the patent in the case. I have stated there fully the advantages between the two systems.

132 Q. Please note that my question did not relate to the date at which you filed your application for the
patent in suit, but it related to the time when you be- 10292
gan your experiments on incandescent lighting?

A. No. When I first started, I started on the wrong track. I started on series.

133 Q. When you switched off from that track onto the other one, did you not know that it would be necessary to increase the resistance of the lamp in some way, if that could be accomplished, in order to secure economical results?

10293 A. After experimenting a long while on the one system, I gradually got the idea that that was the wrong system, that the multiple arc system was the best; and then I found that in the lamps of low resistance the cost of the copper would be too much, and then I appreciated the fact that if the lamp could be made of high resistance I could diminish my copper, and I kept right on experimenting, trying to get a lamp of high resistance so that I could use this multiple-arc
10294 system.

134 Q. How did you find out that if you made the lamps of low resistance it would require too much copper, and that you would save copper by increasing the resistance of the lamp?

A. I do not know how the fact struck me; I guess it was due to my experiments. I am no mathematician, and I never studied any of their laws, and I certainly did not get at it in that way.

135 Q. Can you tell how you did get at it?

10295 A. It is too many years ago.

136 Q. Do you recall any special experiments that diclosed that law to you?

A. To disclose the necessity, you mean?

137 Q. Yes, the necessity, if you please.

A. I don't remember that now.

138 Q. Can you say, as a matter of fact, that that conclusion on your part was the result of actual experiments on different circuits, or was it a conclusion derived from your knowledge of the laws of elec-
10296 tricity derived from the text books, or in other ways?

A. It was derived from experimental knowledge.

139 Q. But you cannot tell now what experimental facts led to that conclusion on your part?

A. No; it gradually dawned upon me.

140 Q. Can you tell about what date?

A. Sometime in the early part of 1879, I think.

141 Q. Was that after Mr. Upton entered your employment?

A. I think so. 10297

142 Q. He was employed as a mathematician, to deal with the mathematical questions connected with the electrical problems that you were interested in at that time?

A. Yes. I am not sure when he came; somewhere along that time.

143 Q. Is it not possible that you got some knowledge in this particular matter under discussion from that source, from Mr. Upton? 10298

A. I possibly might have.

144 Q. You would not want to say that you did not?

A. I would not say that I did not.

145 Q. Is it not possible that Mr. Upton informed you that by increasing the resistance of an incandescent lamp, you could diminish the size of the conductor leading to the lamp?

A. I don't think so; the mathematicians always seem to come after the experiments and explain—not before. 10299

146 Q. Are you referring now to your experience with mathematicians, or is that a general law as to the relation between mathematicians and inventors?

A. It is my experience with mathematicians.

147 Q. When did you first arrange lamps in multiple arc?

A. I do not remember that; it is in my testimony somewhere.

148 Q. Can you fix the date approximately.

A. What kind of lamps?

149 Q. Incandescent lamps. 10300

A. Platinum or carbon?

150 Q. Either.

A. Or any kind?

151 Q. Or any kind.

A. I think I have an old sketch where I showed lamps in multiple arc in 1876 or 1877.

10301 152 Q. I am not asking in regard to sketches, but actual arrangements of lamps that were put on a live circuit.

A. Well, October 5, 1877, my counsel just having shown me this sketch which refreshes my memory. (Deft's. Exh. No. 13, Interference Case).

153 Q. I understand then that you actually arranged lamps in multiple arc on a live circuit October 5,
10302 1877?

A. Yes, sir.

154 Q. How many lamps were on that circuit, and what was their construction in a general way?

A. It is a long while ago to remember; I think I have given somewhere in my testimony an explanation of those lamps and what they were and what we did with them.

155 Q. Of what were those lamps made?

A. I think full descriptions were given in the testi-
10303 mony.

156 Q. Please refresh your recollection by referring to your testimony in regard to this exhibit, and then state of what material those lamps were made?

A. Silicon and Carbon.

157 Q. Are you sure that the exhibit illustrates any carbon experiments?

A. The exhibit don't seem to put in my testimony. I speak of carbon. It may be they were only just silicon.

10304 158 Q. Do you know what the resistance of those lamps were?

A. No, I can't remember now.

159 Q. Have you any means of determining what it was?

A. No, they were very small, I think.

160 Q. What resistance would be "very small?"

A. You mean what would be very small resistance?

161 Q. I mean in what sense did you use that term "very small" in your answer?

A. I can't remember what the resistance was, but 10305
they were little pieces of silicon held between points; these pieces were very much smaller than the head of a pin. The resistance might have been two ohms, or one ohm or one-quarter of an ohm—somewhere down there. It would depend upon the pressure at the contacts.

162 Q. Apparently then, at that time you had not reached the idea of high resistance for the burner of an incandescent lamp when arranged in multiple arc; 10306
what is the fact in that regard?

A. I do not think I had reached the appreciation of the value of a multiple-arc system with high resistance lamps.

163 Q. Can you fix approximately the date when you did reach an appreciation of the value of high resistance in a multiple-arc system of incandescent lamps?

A. My impression is it was round about the early part of 1879 when I got to figuring out the cost of 10307
commercial installations that my appreciation of a multiple-arc system increased, if certain things could be accomplished.

164 Q. In other words, when you began to figure out the cost of an actual plant, you found that you could reduce the cost of copper conductors leading from the dynamo to the lamp by increasing the resistance of the lamp; is that the fact?

A. Well, I should have to qualify that. You can light up a factory, for instance, by using series lamps, 10308
with perhaps even less copper than you could in multiple-arc; but the great distinction comes in in its commercial application, and that is, that if you did it in series, each lamp would not be independent, all would depend on the others; whereas in multiple-arc each lamp would be independent of the others; so there are two things that must be taken into consideration in answering the question.

10309 165 Q. Was it not, after all, Mr. Edison, a mere matter of calculation with you in determining the relation between the size of the copper conductors and the resistance of the burner of the lamp?

A. I knew that the higher I could make the resistance the less copper I could use in my multiple-arc system.

166 Q. Did you find that out by actual experiment, or was that a matter of calculation before experiment?

10310 A. I think I found it out by actual experiment, because I am no mathematician, and never use figures.

167 Q. But you cannot tell now the character of the experiments that led to that conclusion?

A. No; I am always led by my experiments. I have, of course, a system of mathematics of my own, but I do not use Arabic numerals.

168 Q. Do you remember whether you ever made an experiment in which you had incandescent lamps of low resistance arranged in multiple arc, and found as a
10311 matter of fact that it required so much copper to feed those lamps that you deemed it desirable to increase their resistance so as to diminish the amount of copper used?

A. I must have arrived at it by some experiments that I tried.

169 Q. Did you ever try such an experiment as I have just indicated?

A. Yes, sir.

10312 170 Q. When, and what were the data of that experiment?

A. Well, I don't remember them now.

171 Q. Then how can you say that you tried that particular experiment?

A. Because I do not depend on figuring at all, or mathematics. I do not make a practice of using it at all. I try an experiment and reason out the results, somehow, by methods which I could not explain.

172 Q. But a little while ago you said that you drew 10313
conclusions in regard to the necessity of high resistance by figuring on the cost of an incandescent plant?

A. Well, the word "figuring" is used in a different sense from what you probably mean.

173 Q. I understood you to imply by your former statement, to which I have just referred, that when you came to figure out the cost of an incandescent plant, you found that it would require too much copper for
economy if you used a low resistance lamp, and that it 10314
would be economical for you to increase the resistance to a certain point. Did not that involve mathematics?

A. No, sir.

174 Q. In your answer to Question 475, in the McKeesport suit, you speak of having "proved that a "chamber made entirely of glass, by fusion, through "which the platinum wires passed, maintained as table "vacuum." Was not that fact in connection with chambers made entirely of glass, known before your experiments in that direction? 10315

A. I don't know of any such chamber where considerable current was passed through the glass, and an incandescent conductor kept heated for a great length of time, to prove whether it would keep stable. I think there have been cases where platinum wires have been put in a chamber and rendered incandescent, but I don't know whether they run them long enough to prove that they were stable. It would be very hard to prove it with a platinum burner, but the carbon is so
very sensitive to any deterioration in the vacuum that it 10316
could be easily proved with the carbon.

175 Q. Do you mean to say that one would have to experiment with the carbon to find out whether it would remain stable in a high vacuum formed inan all-glass globe, or would he know beforehand without experiment, that if he could get such a vacuum, and have the vacuum remain permanent, the carbon would be stable?

10317

A. I do not know what any other person would have known, but it is very difficult to say what would be known beforehand. When you are dealing with electricity, and a piece of carbon at most brilliant incandescence under conditions never before tried, it is very difficult to say what would occur. I have stated in the patent in controversy what I had found out; that by making the lamps and trying the experiment, I found it was stable.

10318 176 Q. You had had a good deal of experience with carbon, and with carbon used as an illuminant, before you made your first all-glass globe, had you not?

A. Yes, sir.

177 Q. Did you not know reasonably well from those experiments that, if you could only secure a high vacuum in a globe made entirely of glass, you could maintain carbon as a burner in that vacuum or vessel?

A. Well, I expected it, or I would not have tried it; but when I did try the experiment, the results were
10319 far more favorable than I expected, as set forth in the patent.

178 Q. You do not regard yourself, do you, as the discoverer of the fact that carbon, when subjected to a high temperature in a high vacuum formed in an all-glass globe, will remain stable?

A. Well, I have always believed that I was the first one.

179 Q. You assumed from your early experiments that the deterioration of your carbons came from the
10320 effect of the oxygen attacking the carbon, did you not?

A. No.

180 Q. What, then, led you to expect that if you could place your carbon in a highly exhausted all-glass vessel, it would remain stable.

A. I thought it would remain stable as far as oxidation was concerned; but I did not, as I have stated be-

fore, think that it would stop the disintegration of it 10321
entirely, because I had read something about incandescent lamps, and it seemed that they all universally stated that there is a deterioration; that a great many persons who have experimented with incandescent lamps stated that there is a blackening of the globe. Now, this blackening could not be due to oxygen, because there would be no blackening. The oxygen would form carbon monoxide. I saw, independent of the oxygen, there must be the matter of disintegration that 10322
I was afraid of, but I thought that perhaps, having got rid of all oxygen, this disintegration would not be so large a factor as to prevent the use of a lamp for commercial purposes, and the discovery I made was that this did not take place under the conditions of a high stable vacuum.

181 Q. What causes the blackening of the globe in an ordinary incandescent lamp—commercial lamp?

A. I have spent over a hundred thousand dollars in trying to find out, and I don't know. 10323

182 Q. Have you not stated in one or more of your patents that it is due to the convexion of particles of carbon by the currents sent up in the small amount of air that is left in the globe?

A. Yes, sir, I have, but that don't seem to be the entire cause.

183 Q. Is it, in your opinion, one of the causes?

A. Under certain conditions it is one of the causes. I have found out lately that mercury is another cause —mercury vapor in the lamp. With incandescent 10324
lamps it is very difficult to determine exactly the causes, as it takes such a long while—several months—before you can really know, and if one thinks he has struck the right thing after a little while, he applies for a patent; but it may not be the solution of the thing, as time might bring out the fact that it would still disintegrate.

10325 184 Q. In your answer to question 475 in the McKeesport suit, you say that you had known for a long time, and knew in 1877, "that carbon had the requisite resistance to afford a very simple conductor to accomplish the object," the object referred to by you being the use of the lamp in the multiple-arc system of distribution. Do you, in that statement, refer to the specific resistance of carbon?

A. Yes.

10326 185 Q. You also say in that answer that you knew in 1877 that the carbon conductor would have to be made "hairlike." How did you come to that conclusion in 1877?

A. I can't remember. I see here in my exhibit No. 4 (Interference Case) that I say boron is a very high resistance, and would do if arranged thus—multiple arc. Silicon, on the other hand, is very low in resistance, and would have to be arranged thus—series. I cannot answer at this date how I came about it. I
10327 suppose I must have known at the time that the higher I got the resistance the nearer I would get to the solution of the problem I was after.

186 Q. You had not made any carbon burners that were "hairlike" in form as early as 1877, had you?

A. No, I had not. The conditions were they should be stable.

187 Q. And yet you knew in 1877 that carbon would have to be made hairlike in order to serve for an incandescent lamp arranged in multiple arc?

10328 A. Yes, I think so, and that is the reason why I started my first experiments on electric lighting by series.

188 Q. But you cannot tell now how you came to that conclusion in 1877?

A. Well, I think I came to it by experimental knowledge.

189 Q. But not by experimenting with any hairlike

carbon burners? 10329

A. No; I think not.

190 Q. Then wasn't it probably largely a matter of calculation from the experiments that you made with other kinds of burners of lower resistance than hairlike carbon burners would have?

A. Well, I could sit here ten years and answer such questions as that and the total result would be nothing.

191 Q. Well, what would be your answer to the question? 10330

A. Everything is probable. I don't see the use of going into probable things that took place years ago. I cannot remember them.

192 Q. In your answer to question 475 in the McKeesport case, you say, "the moment that I had got "apparatus and means and methods whereby I made a "chamber wholly of glass, and with the McLeod gauge "on the Sprengel pump, had determined that it held a "vacuum continuously, I knew that I could make the 10331
"hairlike filament permanent, provided the filament "itself could be made sufficiently homogeneous." How did you know that before actual trial of a hairlike filament carbon?

A. I knew that in all cases that I had tried, and all that I had read of, that the means used were not adequate to the production of a vacuum which would permit even their large carbons to be used, much less the use of a fine filament; and I reasoned that, if I could only produce a vacuum sufficiently high, I might be 10332
able to use a fine filament—not only a large filament, but a fine filament, and that it would be stable outside of unknown phenomena which occurred of the gradual disintegration of the carbon; that I did not know how long it would take to destroy the lamp, but supposed it might be diminished to such an extent that it would still be a commercial lamp.

10333 193 Q. Is it not a fact, Mr. Edison, that as soon as you had made a highly exhausted all-glass platinum-burner lamp, and found that it would maintain its vacuum, you were confident that a carbon filament would remain stable in that same vessel and vacuum, provided you could make the filament homogeneous.

A. I believed that by substituting a filament of carbon for that of platinum, it would be stable. I did not have any doubt but what I could make a filament
10334 of carbon sufficiently homogeneous for the purpose; the platinum lamps which I used, however, did disintegrate to the extent of tinting the globe with a vapor of platinum, and I supposed that this effect would take place even when I used the filament of carbon under the conditions, but I hoped it would not be to such an extent as to render it uncommercial, and I was surprised to find that it did not blacken at all, and that is the discovery that I set forth in the patent, and I have emphasized the word "stable," and used
10335 instead the words "absolutely stable."

194 Q. Once more I desire to ask you if it is a fact that the carbon filaments do not blacken the globes at all; on the contrary, is it not a fact that the commercial carbon lamps of all manufacturers do sooner or later become tarnished?

A. For instance, if a person's dining room was lighted up by incandescent lights, it would be about two years and a half before any tint would be noticed. I did not know at the time of applying for the pat-
10336 ent that this would occur, as I could not wait six or eight months to determine that before I applied for the patent; but still it is so small, it is not a matter of very much consequence.

195 Q. How was it with the lamps made by you in 1880; did not the globes of those lamps tarnish after a few weeks use?

A. There was some of them that did, but some of them didn't.

196 Q. As a rule, how was it? 10337

A. I think that after burning three or four weeks they would show a slight tint. Of course in those days, we did not run the carbons up to such great incandescence as we do now, because it was very early in the art, and we had not got so expert as we have now.

197 Q. Do you remember when you first got a Sprengel pump?

A. Some time in the middle of 1879. 10338

198 Q. In your answer to cross question 232 in the Sawyer and Man Interference, referring to the experiments made by you with carbon in the year 1878, you say "my second attempt was successful in the form "shown in patent No. 224,329, but in vacuo it was not "successful, except that it proved that carbon from "paper or organic material would be a success for light- "ing by incandescence if it could be made to stand." How did your experiments of that year made "in vacuo"—being, as I understand, the experiments in 10339
which you used strips of carbonized paper under a bell jar on an air-pump—prove that carbon from paper or organic material would be a success for lighting by incandescence if it could be made to stand?

A. Because when it was first lighted up, it seemed to be quite even in temperature.

199 Q. If I recollect, the carbon lasted only a very short time in this experiment?

A. Yes, very short.

200 Q. Perhaps less than a minute?

A. I guess about that time. 10340

201 Q. Was there anything connected with those experiments that led you to the conclusion that the successful incandescent lamp would have to have a filament hairlike in form?

A. If I worked it in multiple-arc, the lamp, I knew, should have high resistance.

10341

202 Q. Those experiments in 1878 did not teach you that, did they?

A. I cannot remember now; you have already gone over this question before.

203 Q. Those experiments in 1878, where you used strips of carbon under the bell jar of an air-pump, had nothing to do with multiple-arc lighting, had they?

10342 A. Yes, I think so. As an experiment it stands by itself; as to what result I put the experiment to, is a different thing altogether.

204 Q. I mean this; you did not have those carbons arranged in multiple arc at the time of the experiments, did you?

A. The experiment shows on its face. It is not made for multiple-arc, or series, or anything. It was simply an experiment in vacuo with a piece of carbon.

205 Q. A single piece?

A. Yes.

10343 206 Q. Now once more let me ask if you can state when first you arranged carbon-burner lamps in multiple arc in actual use, either for commercial lighting or by way of experiment?

A. I prefer that you should refer to my previous testimony given in different cases.

207 Q. That answer I do not think is sufficient. I do not know of any case in which you have given testimony upon the point now inquired about. I am perfectly willing that you should refresh your memory
10344 by reference to such cases, if you know of any?

A. That would be a very long and tedious job to read over all the testimony which appears to be in this case. I am quite certain that I have in some interference or case, testified to the fact when I first used a number of carbon lamps in multiple-arc; and of course if such testimony cannot be found, I will try and refresh my recollection as to that and testify to it?

208 Q. Are you now unable to state, even approximately, when first you arranged carbon lamps in multiple-arc? 10345

A. Without refreshing my memory I think it was around November, 1879.

209 Q. Do you know whether you had done it before you applied for the patent involved in this case?

A. Yes, I am pretty sure I did. I would have to refresh my recollection by looking up the notes.

210 Q. If you had done it before you applied for this
patent, I presume you would have some memorandum 10346
of it in your note books, would you not?

A. Well, I might; that is presumable.

211 Q. Will you kindly examine your note books of that period, and if you have any memorandum showing when first you arranged carbon lamps in multiple arc, will you kindly produce them at the next session?

A. That will be quite a job for me, and if it is not absolutely essential, and it could be found stated in the evidence, will that be sufficient?

Counsel answers yes. 10347

212 Q. In your answer to cross-question 392 in the Sawyer and Man Interference, you say: "I was perfectly aware when I made the Exhibit First Incandescent Lamp that organic carbon was the proper kind to use, as with a small mass it had high electrical resistance." Did you, in that statement, mean that organic carbon was preferable to hard carbon or coke, or did
you mean that carbon was better than other substan- 10348
ces for purposes of incandescent lighting?

A. There are two ways of getting high resistance in the lamp; one is by making the filament thin and long, and the other is to make it of a kind of carbon that is not solid—whose structural arrangement is cellular. This is the case with organic carbon. The carbon itself may be as dense as the gas-retort carbon, but the resultant product of the decomposition by heat is such

10349

that it retains the original cells due to its vital principle, and that these are one of the aid to increase the resistance of the lamp.

213 Q. In answer to question 486 of your deposition in the McKeesport suit, you speak of the Edison Electric Light Station in the lower part of New York City. What is the size of the conductors used in that system ?

A. They are of various sizes; I suppose you refer to
10350 the mains underground ? They are of various sizes—they are not round, but half-moon shape. If made round, I think they would vary from three-eighths to three-quarters of an inch.

214 Q. Do you remember approximately what the cost of the copper conductors was ?

A. No, I don't remember that. The cost of digging the surrounding material and insulation, and boxes and everything, was two-thirds of the whole cost; that is to say, the copper was about one-third, but as to the to-
10351 tal amount, I don't know. I should say that the cost of the underground system as first laid was $210,000, or thereabouts, the copper being one-third of the cost.

215 Q. In answer to Question 467 of your deposition in the McKeesport suit, you say that in lamps designed for series work "the endeavor is to diminish the "resistance of the incandescing conductor as far as pos-"sible, in contradistinction to multiple-arc system where "the object is to increase the resistance of the incan-
10352 "descing conductors as far as possible." Suppose you have a limited number of lamps to be used in series, is it not better to make the resistance of each of those lamps as high as possible, consistent with the amount of copper that you can afford to put into your conductors ?

A. That is an expert question; I would not like to answer it; still, I will do so if you insist.

216 Q. Is not that a matter of common knowledge among electricians ? 10353

A. They generally want to put a great number of lamps in series, and therefore they make it low.

217 Q. That is the reason why they make the resistance low, because they want to put a large number in, is it not ?

A. That is one of the reasons, but they do not go too low, for the modern incandescent lamp, being all
glass, and having wires sealed through, they do not 10354
like to use too large wires to convey into the lamp the large currents used. Of course, in the last few years, the glass blowers have got very expert and they are enabled to seal larger wires into the glass than we could in the olden days.

218 Q. Suppose you had twenty incandescent lamps to be arranged in series, would it not be better, having regard to economy in the amount of copper used, to make those lamps of high resistance rather than very low resistance ?

A. If the line was very long, better to make it high; 10355
if a very short line it would not matter.

219 Q. Would the same qualification apply in the case of lamps arranged in multiple arc ; in other words, if you have say twenty lamps to be arranged in multiple arc very near to the dynamo, is it not true that it would not make much difference whether the resistance of the lamps is made very high or comparatively low, while it will make a very great difference if the lamps are far away from the dynamo ? 10356

A. The trouble of it is that in incandescent lighting, the pressure is kept constant and the current increases, which requires more copper as you put more lamps on ; whereas in series lighting you only have a current of one lamp and if you put a dozen on, you would not have any more current. The copper question is very serious for multiple-arc lighting even in short distances, but it is not a question at all in series lighting.

10357

220 Q. It is a serious question in series lighting, if you carry your current over long distances, is it not?

A. No, not serious. In many cases we use four or five times the amount of copper that we need because if we put only the size of wire we need, the wind would blow it down; if we put up the Ohm's law size, the wind would blow it down.

221 Q. Aside from your application for the patent
in suit, have you ever made an application for a patent
10358 in which you sought to cover broadly the use of a
carbon filament for an incandescent lamp?

> Objected to as incompetent and as calling for the conduct of the witness subsequent to the transfer of the patent in suit, and immaterial.

A. I remember in some application that the lawyer
who had charge of the patents of the Light Company,
divided some case, but I don't remember exactly what
10359 the claims were.

222 Q. Do you remember whether there was any claim for the combination of a carbon filament of high resistance with an all glass-globe?

A. I thought that was in the patent in suit.

223 Q. No matter about that; I ask you whether in the application which you say the lawyer of the Edison Company made, there was any such claim?

A. I don't remember it.

10360 224 Q. Do you remember the fact that your applica-
tion for a patent for the paper-carbon incandescent
lamp was divided?

A. I think it was. I know we had some trouble about that time with the claims of Sawyer, and the attorney of the company amended and did something which I don't exactly remember just now.

225 Q. Do you remember whether that or any other application which you have made in the Patent Office

had a claim for a flexible filament of carbon? 10361

A. I think that after the patent in question, we put in the paper-carbon application and then we tried to claim flexibility in addition. Whether we got it I do not remember. I don't know how it stands now.

226 Q. Do you remember whether in that application or any other application made by you, or by the Edison Company in your name, there was a broad claim for a carbon filament of high resistance?

A. No, I don't know that. As we had that in the 10362
patent in suit, I do not see why we could have put it
in a subsequent application.

227 Q. If you had it in the patent in suit, it would be very strange that you should put it into a subsequent application, would it not?

A. I do not think that I would do it.

228 Q. It could not have been done by the Company, either in your name or without your name, could it?

A. The company's attorney, after I had furnished all 10363
the information, drew up an application and I signed
it. As long as the descriptive matter was right, I do
not look at the claims. I never look at the claims of
any patent that I take out to-day; I leave that to my
attorney and to his expertness.

Adjourned to Wednesday, June 11, 1890, at 12 M.

10364

ORANGE, NEW JERSEY,
June 11, 1890.

Met pursuant to adjournment.

Counsel present as before.

229 Q. Have you, since our adjournment yesterday,

10365 been able to get any further data as to the time when first you put actual lamps having carbon burners in multiple arc on a live circuit?

A. I have not looked up the data because it would take a very long while to be able to answer that question absolutely.

230 Q. What record have you of that wonderful experiment of October 21, 1879, which, as you have said, threw such a flood of sunlight on the subject of
10366 incandescent lighting?

A. I think some of the records are in the case relating to that particular lamp.

231 Q. Will you kindly indicate where this particular record can be found?

A. There is, I find, in Mr. Batchelor's Book, No. 52, some records of carbons he made on October 21st. These records are found on pages 105, 107, 111 and 115.

232 Q. Have you any other record of that experi-
10367 ment of October 21st?

A. I think there must be some such record; I think Mr. Upton made some records.

233 Q. Can you tell me where that record is to be found?

A. I will have to ask my counsel. My counsel states that he don't know of any more. There is a vault full of record books at the Produce Exchange in New York, running over these periods, which may contain something relating to this matter.

10368 234 Q. I will ask whether you *know* of any other record of that experiment?

A. I think there are some records, but I cannot state absolutely that there is, without going over all these books.

N-790731 [illegible]
[illegible] #52
[illegible]
[illegible]

235 Q. Referring to Mr. Batchelor's book, No. 52, is not this the fact, that pages 99, 101 and 103 of said book contain entries in pencil under date of October 21, 1879, such entries relating to the carbonization of

paper and other materials; and that pages 106 and 107 10369
contain entries under date of October 22, 1879, partly in ink and partly in pencil, relating to the manufacture of lamps; and that pages 111 and 115 contain entries in pencil under date of October 21, 1879, these last entries relating to the actual operation of lamps; while pages 100, 102, 104, 106, 108, 109, 110 and 112 are blank?

A. Yes—correct.

236 Q. Which ones of the pages enumerated contain 10370
the record of the actual operation of the lamp which you say was tested on the 21st of October?

A. If my memory serves me right, it is the No. 9 lamp described on pages 111 and 115.

237 Q. What is the full account of the performance of that lamp as contained on those pages?

A. As the book is in evidence, it speaks for itself.

Counsel agree that the notes referred to by the witness are as follows:

(P. 111) No. 9. Ordinary thread, Coat's 10371
6 cord, No. 24.

Came up to ½ candle, and was put on 18 cells battery permanently at 1.30 A. M.

(P. 115) No. 9. On from 1.30 A. M. till 3 P. M., 13½ hour, and was then raised to three gas jets for 1 hour, then cracked glass and busted.

238 Q. Why, if you know, is that particular lamp designated in the record as "No. 9"? 10372

A. I suppose it is a method that Mr. Batchelor had of numbering his experiments. I only recognize the lamp by the statements made.

239 Q. Immediately above the entry on page 111, in relation to lamp No. 9, is an entry in regard to a lamp called No. 2, which entry begins as follows: "No. 2 lamp of page 107 had," etc., and then follows the entry

10373 already quoted in regard to the lamp No. 9. Do you not infer from that that the lamp No. 9, whose record is given in part on page 111, is the lamp designated on page 107 as No. 9?

A. I do so infer.

240 Q. Have you any doubt in regard to the fact that the person who made the entry in regard to lamp
10374 No. 9 on page 111, was referring to the lamp No. 9 in the list of lamps on page 107?

A. I think that he meant to refer to the same lamp.

241 Q. Have you any other means of determining the date at which the first test of a lamp having a carbon filament was made, except the record in this book which we are now considering?

A. I have none immediately at hand. I do not doubt but what I could find more relating to it should I look over all my record books.

242 Q. Do you rely on this particular record for the
10375 statement that that experiment took place on the 21st of October?

A. No, sir.

243 Q. Upon what do you then rely?

A. Upon my memory absolutely, because it was a great day for me.

244 Q. You were in the habit of keeping records yourself of important events at that period, were you not?

A. I kept some myself, and my assistants kept some.
10376 I do not think I kept many just about that time.

245 Q. Was not that event so important that you would have been likely to make a note of it in your own personal record, if you were keeping one?

A. It would be a most unlikely time for me to make records; such details were trivial in view of what I had got hold of.

246 Q. Do not the entries under date of October 21, 1879, on pages 99, 101 and 103 of Batchelor's book, No.

52, show that at that period you had considerable difficulty in carbonizing the tar putty filament? 10377

A. Yes; we had considerable trouble in doing it, but we finally got out of it by the methods shown and described in the patent in the case.

247 Q. What particular methods described by the patent in the case do you refer to?

A. Wound it in a spiral form, putting it in between a copper spiral.

248 Q. Do you know at what time you discovered that method of manipulation of the tar putty filaments? 10378

A. No, I do not, just now; somewhere around about that date.

249 Q. Have you other books which describe your processes of carbonization, as carried on between October 21, 1879, and the end of that year?

A. I presume we have.

250 Q. Do you know what the fact is?

A. I don't exactly know it, but it is very likely that we have. 10379

251 Q. Did not Batchelor have special charge of that work, and is not this his record?

A. At that time he had charge of the manipulating of the filament and carbonizing of it, with other assistants.

252 Q. Did he keep another record book of that work besides No. 52?

A. We generally had thirty or forty books lying around the laboratory, and some times he would pick up one and make his entry, or pick up another one according as it happened to be lying on the desk. 10380

253 Q. So that the record of your carbonizing experiments may be found in thirty or forty different books.

A. I think so. There must be at least a dozen in the evidence in this case, perhaps more.

254 Q. Do you speak advisedly on that point?

10381 A. I speak from just looking over the case and seeing references made, that there must be a great number referred to in the Exhibits.

255 Q. Do you know that there is more than one book containing a record of your carbonizing experiments which has been an exhibit in this case?

A. I don't actually know it, but I think that I remember that there is more than one. I would have to look the matter up.

10382 256 Q. So far as you know, this book No. 52 which has been put in evidence in several litigated cases, is the most important of your various records in regard to your early experiments in carbonization?

A. That depends on what the book is used to prove.

257 Q. Do you know of any book that contains any fuller or more truthful account of your early experiments with carbon filaments than this book, No. 52?

A. I would not swear that there were not other books that contain very full accounts of carbonization. I
10383 know there were several hundred and I have not seen them for several years and I cannot say. Our practice was to distribute these books freely all over the laboratory, and when we had an idea to make a record of, we would pick up the book nearest to us.

258 Q. My question is, whether you know of any other book that contains a fuller and more truthful account of your early experiments with carbon filaments than this book No. 52?

A. I would have to look at the books.

10384 259 Q. Then you don't know of any book containing a fuller and more truthful account of those experiments, do you?

A. I do not know now. I would have to look at the books.

260 Q. What was about the average life, stated in hours, of the carbons of your commercial lamps as made in 1880 and 1881?

A. I think that is a matter of record in this case.

261 Q. Please state it as nearly as you can? 10385

A. I don't remember now without looking at the record—three or four hundred hours, something like that—the lamps made in December, 1879 and Janrary 1880; by referring to one of the lamp records, I find about 400 hours, average life.

262 Q. What causes put an end to the lamp at the expiration of that time?

A. We have never been able to find out; no one knows to this day. They keep good up to a certain 10386
point and suddenly they break.

263 Q. This is not oxidation, is it, which causes that result?

A. No. I have seen lamps in large numbers that were put up at 16 candles, and would run several hundred hours, and still maintain their candle power within a few per cent., and then suddenly break, the filament would actually break; and as an arc would form at the moment of breaking, it would by its action on the carbon mask all traces of the origin of the 10387
cause of the break.

264 Q. Does not the life of a carbon filament of a given size and length depend very materially upon the mode of manufacture?

A. It depends on the mode of manufacture, and on the original material, and a great number of things.

265 Q. In other words, I suppose a carbon filament of a given diameter and length will last very much longer if made by one process, than a filament of the same diameter and length if made by a different pro- 10388
cess?

A. Yes.

266 Q. You say that you are unable to determine what it is that causes the destruction of the carbon burner in the modern incandescent lamp. What is it that caused the speedy destruction of the carbons in your early experiments in 1877 and 1878?

10389 A. Caused by oxidation and disintegration.

267 Q. What was the evidence of disintegration in those carbons, which went to pieces, if I understand you, very quickly after the current was turned on?

A. They oxidized before they had a chance to disintegrate. We saw disintegation when we used larger masses and of harder carbon, the disintegration showing by the blackening of the vessel. Oxidation does not cause it to blacken, because the carbon combines with
10390 the oxygen to form a gas.

268 Q. Do not your incandescent lamps, as well as those of other manufacturers, run down somewhat in candle power after they have been in use for a few weeks?

A. Yes, sir, they do.

269 Q. About what percentage of deterioration in that respect?

A. It depends on the economy at which you run the lamp. If you put a modern incandescent lamp down to
10391 seven lamps per horse power of 16 candles each, it propably would not vary a candle in a year of three hours a day burning. If you placed the same lamp up to an economy that it would give 14 lamps per horse power, it might go down to 11 candles from 16 in the same time.

270 Q. What is the explanation of the loss of candle power?

A. No explanation. The carbon changes its resistance from some unknown reason.

10392 271 Q. What is the smallest filament of carbon that you have ever been able to make that would withstand this disintegration under a powerful current?

A. All carbons will disintegrate if you put enough horse power of current through them. The advantage of diminishing disintegration is that it allows you to get more lamps for a horse power, and, consequently, make the electric light cheaper; and, therefore, disintegration means dear or cheap electric lighting. Small

disintegration, more lamps per horse power; greater disintegration, less lamps per horse power, assuming both are put up to the same relative temperature. 10393

272 Q. I think you have not quite answered my question. Please consider the question carefully. (Question read).

A. I have made filaments of carbon two and one-half thousandths of an inch in diameter that gave twelve 16 candle lamps for a horse power, and were very good commercial lamps. Of course, as I have previously 10394
stated, there is a slight disintegration over long periods of time, but not sufficient to interfere with their commercial use.

273 Q. Is that the smallest carbon filament that you have ever tried?

A. If you refer to diameter and to being commercial lamps, I think it is.

274 Q. Do you think it would be practicable to make commercial incandescent lamps with carbon filaments not exceeding one one-thousandth of an inch in diameter? 10395

A. Yes, I think it is practicable to do so, and I am trying to do so.

275 Q. How long have you been trying to do that?

A. About six weeks.

276 Q. It would be a very desirable result to accomplish, would it not?

A. It depends on what system you use. I refer to a system of distribution.

277 Q. I assume that the lamp is to be used in multiple arc? 10396

A. It would be desirable, as it saves investment in copper. The trouble is that competition has caused lamps to be made now with exceedingly high efficiency, which means exceedingly high temperature; and so anything that is got in the way of saving copper must be got with these very difficult conditions tacked on to it.

10397

278 Q. In your answer to question 475 in the McKeesport suit, you say: ' In my early experiments with platinum lamps, the thing I desired is therein detailed." etc. What do you mean by the word "therein?"

A. I desired a high resistance lamp.

279 Q. You say the thing you desired was "therein detailed," meaning, as I understand, that it was described in some particular place to which you make
10398 reference. Where is that description found?

A. I think I speak in that patent of the desirability of having a high resistance lamp.

280 Q. Then the word "therein" refers to your patent 227,229, relating to the platinum lamp?

A. Yes, it refers to patent 227,229.

281 Q. What was the highest resistance used in any of your carbon burners prior to the famous experiment of October, 21, 1879?

A. I don't remember.

10399 282 Q. About how high should you think?

A. I don't remember without referring to my records, and I don't know even that any measurement of resistance was made.

283 Q. When did you first know of the capacity of a Sprengel pump to produce a very high vacuum?

A. I think I read something about it in some scientific book, somewhere in July, 1879.

284 Q. When did you first know of a better pump for producing a vacuum than the ordinary mechanical
10400 air pump?

A. I think sometime in the middle of 1879.

285 Q. Then your difficulty in procuring high vacua before that time arose from your ignorance of the existing means whereby such vacua could be produced, did it not?

A. I don't know. I had an air pump and I tried experiments on that, but I read of the Sprengel pump

and I thought that would be better, and I got that and 10401
it was better.

286 Q. When did you first find out that carbon had the requisite resistance for use in incandescent lamps arranged in multiple arc?

A. I think that is all in the testimony. It has been stated and reiterated.

287 Q. Did you consider yourself the discoverer of the fact that carbon had a resistance better adapted for such use than other materials have? 10402

A. I don't know as I have ever considered that question very much.

288 Q. Did you not know what the resistance of carbon was when you first gave your attention to incandescent lighting?

A. That kind of questioning don't really amount to anything for the simple reason that there is about a thousand different kinds of carbon, and they all have different resistances under all kinds of different conditions. The carbon coming from the carbonization of 10403
paper is different from the carbonization of bamboo, and so all through carbonaceous nature which gives a carbon residue.

289 Q. Still it is a fact that carbon, using the term generally, has a very much higher resistance than platinum, for instance, or any of the metals?

A. You may take a diamond—a diamond is not a conductor at all, and yet it is a pure carbon. If you qualify your statement I can understand it, but if you ask me—make a bald statement, and ask me a bald question, you must make them so that I can give you 10404
accurate answers.

290 Q. Cannot you answer the last question without having it made more specific?

A. If you will ask me specifically, I will answer it with pleasure.

291 Q. When did you first know that the specific resistance of the carbons that you first experimented

10405 with in incandescent lighting was higher than that of the metals?

A. I cannot remember now, but I am certain it is somewhere in evidence in these cases.

292 Q. Did you find out that fact from your own investigation or did you learn that from the books?

A. I can't remember that now. I don't read very
10406 many books. When I start in to experiment with anything, I do not read the books. I don't want to know what has been done.

293 Q. But you do employ men to read the books and bring the results to you, do you not?

A. Only in late years, I have adopted that practice.

294 Q. You adopted that method with Mr. Upton when he first came to you, if I remember aright his testimony?

A. No, I think not. I don't think I had many books then.

10407 295 Q. Was he not pretty diligently employed for many months after he came to you in examining the whole art of electric lighting?

A. I don't remember as he was He came to me as a mathematician, and his mathematical knowledge I found was of no avail.

296 Q. Practically, has there not been great difficulty encountered by manufacturers generally, including yourself, in making carbon filaments homogeneous?

A. It is according to what you call the word "hom-
10408 ogeneous." I have made a great number of carbon filaments which I could not imagine were not perfectly homogeneous, and yet they would run for a great number of hours and then suddenly, without any warning, break. This might imply a want of homogeneity, and in that sense, if that is want of homogeneousness, then we have had great difficulty.

297 Q. I borrowed the term "homogeneous" from the last part of your answer to question 475 in the Mc-

Keesport suit. Please answer the question consider- 10409
ing the term used in the same sense in which you then used it.

A. What I meant by homogeneous in that answer was not theoretically homogeneous, but sufficiently homogeneous—sufficiently near alike in all its parts to do the business.

298 Q. You have somewhere intimated, if not directly stated, that in your experiments with the in-
candescent lamp, you departed from the line of opera- 10410
tions of other experimenters in that you adopted the *multiple-arc* arrangement, while they were working on the other plan of the *series* arrangement of lamps. Do you consider yourself the discoverer of the superior advantages of the multiple-arc arrangement as applied to incandescent lighting?

A. I think I was the first to use it in connection with a practical lamp which permitted the use of the system.

299 Q. That does not quite answer my question. 10411
(Question read).

A. I think the patent in controversy clearly shows, in connection with the claims, what I thought myself entitled to; and that is as far as I want to go.

300 Q. Then you do not care to answer the question?

A. No, I think I'll leave that with the patent.

301 Q. Do you think that the patent answers that question?

A. I think it pretty fully states the advantages of 10412
multiple-arc, and shows the method whereby those advantages can be obtained.

302 Q. Conceding all that for the moment, does the patent anywhere indicate that you consider yourself the first to recognize the advantages of placing incandescent lamps in multiple-arc rather than in series?

A. I don't think that has got anything to do with the case, any way.

10413 303 Q. I ask you if the patent makes any statement of that kind?

A. The patent speaks for itself.

304 Q. You have referred me to the patent for an answer to the question which I have propounded, in lieu of making a direct answer to the question. Now I ask you whether, in your opinion, the patent does fairly answer the question which I put to you?

A. I would not like to give an opinion on the patent;
10414 that is for the judge.

305 Q. Have you any objection to my knowing whether you deem yourself the first to have recognized the advantage of placing incandescent lamps in multiple-arc?

A. I don't want to go into any play upon words, or make any statements.

306 Q. I do not consider this any play upon words; I am only asking for a fact to which, it seems to me, I am entitled.

10415 A. I prefer not to answer it.

307 Q. Have you or not any belief as to whether you were the first to recognize the advantage of placing incandescent lamps in multiple-arc rather than in series?

A. I don't know whether I was the first to recognize it; I have not gone over the whole art; the experts have. I believe that I was the first man to make multiple-arc lighting with incandescent lights practicable and commercial.

10416 308 Q. In answer to Question 485 in the McKeesport suit, speaking of the time when you first took up the subject of incandescent electric lamps, you say that "the correct principle upon which to build them" had not been, so far as you know, discovered. What is the "correct principle" to which you referred?

A. It is fully set forth in the answer.

309 Q. Will you please state it, in what words?

A. Do you refer to the principle?

310 Q. What is the "correct principle" to which you in that sentence refer? 10417

A. The correct principle is fully set forth in the patent in controversy.

311 Q. I still must ask you to answer the question.

A. Perhaps I don't understand the question. Please read it again.

312 Q. (Question 308 read).

A. That is fully set forth in the patent in controversy. 10418

313 Q. There are a good many things set forth in the patent in controversy, and therefore your answer to my question is indefinite. I must ask you as a favor to make a direct answer to my question, if you can?

A. I will answer the question if you will point out in the patent in controversy any more than one principle in the patent.

314 Q. Are you unable to state, in your own words, what the "correct principle" is, to which you referred in your McKeesport testimony, answer 485? 10419

A. I don't like to answer the question you have put, because a great deal of it is expert, and I don't want to go into a long-winded splitting of hairs.

315 Q. It seems to me that you ought not to have any objection to explaining testimony which you have already given on this subject voluntarily, and which has been made a part of the record in this case?

A. Therefore, to shorten the answer, I refer you to the patent as the clearest exposition—clearer than any explanation that I might make. 10420

316 Q. Do you know what you had in mind when you used the words "correct principle" in answer 485 of your McKeesport deposition?

A. Yes, I know what I had in mind.

317 Q. What was it?

A. It was described in the patent in controversy.

318 Q. What principal thing in the patent?

A. The principle.

10421 319 Q. What principle is described in the patent that you then referred to?

A. Only one there.

320 Q. Please state what it is?

A. Look at the patent.

321 Q. I might read the patent differently from what you do?

A. There is only one principle.

322 Q. Do you mean that the "correct principle" is
10422 that you must have a high resistance for the burner if you are to work in multiple-arc?

A. I am not experting on that patent.

323 Q. I am not asking you now what the patent means; I am asking what you meant when you used the language quoted from answer 485?

A. I have already stated that it is described fully in the patent in controversy.

324 Q. You don't say what thing in the patent?

A. I have said there is only one principle in the pat-
10423 ent, and it requires no explanation from me.

325 Q. Then you decline to explain the words stated in the foregoing deposition, do you?

A. I decline to make any other statement than that to save time.

326 Q. Don't you think you would have saved a great deal of time if you had given me a direct answer?

A. That depends upon the counsel who is examining me.

10424 327 Q. In view of the obstinacy of the counsel who is examining you, don't you think it would have been a saving of time to have answered the question directly, man-fashion.

A. I was not aware that the counsel examining me was an obstinate man.

328 Q. You know that the name imports Scotch descent, do you not?

A. I ought to have known it.

10425

Cross-examination by Mr. Dyer:

329 x-Q. I call your attention to pages 219, 221 and 223 of Mr. Batchelor's note book, No. 52; are the figures given in the last column of the table on pages 221 and 223 under the head of "Resistance after sealing" the measurement of the resistance with the carbon hot or the carbon cold?

Objected to as immaterial.

A. The resistance of the lamps in the fourth column 10426
marked "Resistance after sealing" is the resistance of the lamp when measured cold.

330 x-Q. Are these lamps referred to on pages 219, 221 and 223 a fair sample of the average of the lamps in resistance, made by you in 1879.

A. Yes, they are. They were made for the exhibition given at Menlo Park on January 1st, 1880, to the public.

331 x-Q. I call your attention to your answer to the
46th question in your deposition taken from the Mc- 10427
Keesport case, and which is quoted in Professor Cross's answer to 21; in view of the data to which I have called your attention, do you wish to make any explanation of or correction in this answer?

A. I was mistaken evidently in my statement made in the McKeesport suit, as to the resistance hot; I probably had in mind the ratio between the resistance hot and the resistance cold of our present lamps when I made the answer. I now remember that the same
ratio does not hold for a paper-carbon lamp, and I 10428
think it comes down considerably more when hot. The resistance was probably hot somewhat less than 100 ohms.

332 x-Q. In your answer to the 21st question of your deposition in the Interference proceeding, which comes into this case as a part of your deposition taken from the McKeesport case, you use the statement that in Nov-

10429 ember or December, 1879, "our calculations showed us that the lamp must have at least one hundred ohms resistance to compete successfully with gas," and this matter is quoted by Professor Cross in his answer to question 21. Do you mean that your calculations had shown that 100 ohms resistance was necessary in order to produce a successfully commercial incandescent lamp?

10430 Question objected to as leading.

A. This refers to erecting the first station and competing with gas in the City of New York. If it had referred to a small plant, it would call for a low-resistance lamp, because it is not necessary in a small installation to have so high a resistance lamp. It refers to distribution on a large scale—on the scale which I intended and afterwards carried out in New York City. The statement was simply not qualified, that is all.

10431 333 x-Q. Was the price of gas an element in this calculation?

A. Certainly.

Re-Direct examination by Mr. Duncan:

334 Q. What lamp was made the subject of the calculations referred to in your answer 21 in the Sawyer-Man interference, where you say "our calculations
10432 showed us that the lamp must have at least one hundred ohms resistance to compete successfully with gas?"

A. Well, it was a lamp we were trying to get.

335 Q. Not any lamp which you had got?

A. Not in December, 1878.

336 Q. These calculations were made in December, 1878, were they?

A. Yes, I think about that time.

10433

337 Q. Then after all, it would seem, would it not, that your conclusion reached in December, 1878, that in order to effect a practical subdivision of the electric light, the lamp should have a high resistance and small radiating surface, in order to be worked commercially in multiple-arc, was the result of "calculation" and not of actual experiments made with such lamps?

A. That does not follow.

338 Q. Had you at that time made any carbon lamps having high resistance and small radiating 10434
surface?

A. I should have to look over my note books to see; I don't remember any.

339 Q. Have you preserved those calculations?

A. I have already testified that I arrived at my calculations by methods not ordinarily used.

340 Q. Were those calculations put on paper and has the record of them been preserved?

A. I don't know; I would have to look over the records. 10435

341 Q. I judge from your answer to question 332 that the resistance which it is necessary for an incandescent lamp to have when arranged in multiple-arc depends very considerably upon the number of lamps to be employed in the particular installation, is that your view?

A. Yes; if you want to compete with gas on a large scale, of course you have got to go over a large area and use a large number of lights, and therefore want a large resistance. If, on the other hand, you want to light a mill or a large store or something 10436
like that—locally—it is not necessary to have lamps of such high resistance.

342 Q. Even if arranged in multiple-arc?

A. Even if arranged in multiple-arc.

343 Q. How wide a range of resistance would be permissible between, for instance, a plant used to light

10437 the different alcoves of this room, and a plant such as would be necessary to light up one-half of the city of New York?

A. Well, that is an expert question. These men that understand figuring could probably figure that out better than I could. It is a commercial question. In lighting this laboratory, if you had one-ohm lamps you
10438 might want copper rods around here about an inch in diameter. Just as you increase the resistance of your lamp, just to that extent would you diminish the copper.

343 Q. When you made those calculations in 1878, which you now say had to do with lighting the city of New York, did those calculations contemplate the lighting of the entire city from a single centre of distribution?

A. No, sir, it contemplated dividing the city up into a number of sections about from a half to three-quar-
10439 ters of a mile square.

344 Q. Suppose you had chosen at that time to divide the city up into four times as many sections; what difference, approximately, would that have made in the necessary resistance of the lamps?

A. Well, we could use lamps of very much lower resistance.

345 Q. Approximately how much lower?

A. Two or three times lower I should think; but then the trouble comes—the great cost of real estate
10440 would come in in having so many stations.

346 Q. So if your calculations had contemplated supplying the entire city of New York from a single centre of distribution, what, approximately, would have been the necessary resistance of the lamps?

A. According to what sytem you used.

347 Q. Using the same system on which your calculations were based in 1878?

A. That depends on the contour of the island and the distribution of light. That is so large a question I

would not like to answer that or even give an approximate answer. 10441

348 Q. The resistance would have had to be increased several times, would it not?

A. Well, we might take one area and work it in multiple-arc in the regular manner, and then take another area and work it in the regular manner, and then put the two areas worked in multiple-arc in what is called a series, as a whole. In that way you might
go over the whole island without using any higher resis- 10442
tance than you did with one station.

349 Q. Suppose that all parts of the island were to be connected to the central station in precisely the same way in which, in your calculations of 1878, you proposed to connect the parts of each section of the island. Then what approximately would have been the necessary resistance of the lamps employed?

A. That depends upon the amount of amperes which each lamp takes.

350 Q. Giving each lamp the same amperes as was 10443
contemplated in your calculations?

A. One lamp might have a resistance of one hundred ohms and require a pound of copper, and another lamp might have a resistance of one hundred ohms and require only a half pound of copper. It depends upon the temperature also.

351 Q. You would have proposed, under those circumstances, to employ lamps of different construction for different parts of the same system, would you?

A. No, sir, I would not. 10444

352 Q. Then what resistance, approximately, do you think it would have been necessary to give to each?

A. This whole question is a large one; it is very complicated—several miles in diameter. When you ask me for mere resistance, that is only one thing in the answer. It depends upon a great many things.

353 Q. I understand you to say, however, that in your calculations in 1878, you proposed to subdivide

10445 the city of New York into quite a large number of separate sections from a half to three-quarters of a mile in area, and that the resistance of the lamps to be used in each one of those sections would have to be at least one hundred ohms. I also understand you to say that if you had reduced the sections of the city to one-fourth of that size, you could have reduced the resistance of the lamps perhaps two or three times. Now would it not have been necessary, if you had en-
10446 larged the area of the separate sections to be lighted, that you increase the resistance of the lamps?

A. Yes, sir.

354 Q. And if you had contemplated covering the whole city by a single plant, the resistance of the lamps would have necessarily been carried up very far beyond 100 ohms, would it not?

A. Yes, it would, but we did not contemplate it.

355 Q. According to your calculations of 1878, about what would the resistance of the lamps necessarily
10447 have been, if you had contemplated lighting the whole city by a single plant?

A. You might extend that to the whole United States. It is a thing that was not contemplated and would not be contemplated in that state of the art.

356 Q. Why? Because you could not make lamps of sufficiently high resistance and at the same time of sufficiently small radiating surface?

A. In 1878 we had not got there; we thought we knew what we wanted but we had not got it.

10448 357 Q. You had not got at that time, either, lamps with which you could light small areas?

A. No, sir, but we thought we knew what we wanted and we were trying to get it.

358 Q. Then this was a purely theoretical calculation of yours in 1878, that the lamps would have to have a resistance of one hundred ohms, was it not?

A. As you have returned to that question so many

times, I will just state that it is not necessary in all 10449
calculations to determine everything in this way. For instance, if I have a certain lamp of any size whatever, and I have a wire attached to it, and that wire by the feeling reaches a certain temperature, and I say to myself, we don't want the wire to get any hotter, and that wire weighs an ounce, a simple mental calculation would show that if you were to put one million lamps on the wire, that the resistance of the lamps would have to be increased. You don't have to go through 10450
any algebraic calculations to determine that.

359 Q. But you do have to go through some mathematical calculations in order to determine the exact ratio between the resistance of the lamp and any definite area that it is proposed to light with that lamp?

A. But up to the present time we have never been able to apply mathematics to that determination. So far they have always been a failure, and even to this day, after they have attempted to figure out the size of the mains and feeders of a general system of dis- 10451
tribution, I have had to come in and correct the whole thing on a common horse-sense basis, and show them where their errors were, and approximate as nearly as possible, and come as near guessing to the correct size as possible in the present state of the art.

360 Q. These calculations of 1878 were mathematical calculations, were they not?

A. I did not say so.

361 Q. I know you did not say so, but were they
not in fact? 10452

A. I don't remember that they were.

362 Q. What do you mean, then, by the word "calculations," when you testified as you did in answer to question 21 in the Sawyer and Man interference?

A. A mental operation—not necessarily the using of Arabic numerals.

363 Q. But you had to use Arabic numerals in reaching the conclusion that one hundred ohms was

10453 the necessary resistance for lamps to be used in those special areas which were covered by your calculations?

A. You are splitting hairs.

364 Q. *Somebody* seems to be splitting hairs.

A. It is not me.

365 Q. On page 211 of the Bachelor record, No. 52, under date of December 8, 1879, I find a table of resistances which begins as follows:

Resistance of lamps.
10454 At first
141—295—157 after heating.
142—300—150 " etc.

Please explain the first line of that entry?

A. The resistance 295 of, say lamp 141, means resistance before the current is passed through the carbon. 157 ohms means after the current has passed through the carbon. There is a change of resistance between filaments after they have been carbonized by heat and after the current passes through them. It
10455 does not mean that they were measured hot; it simply means that the resistance was changed after electrical heating while manufacturing the lamp.

366 Q. Referring to the fourth columns on pages 221 and 223 of book 52, how do you know that those columns represent the resistance cold?

A. Because I remember without reference to the book that we used to measure that on a Wheatstone bridge, which we had made by Elliot Brothers, and there was no provision for measuring them hot with
10456 that bridge.

367 Q. Did not you ever, in those days, measure the resistance hot of the carbons by some method?

A. I think we got a method for measuring them hot sometime in January, 1880.

368 Q. For practical purposes it is necessary to know the resistance hot of a lamp, is it not?

A. No; we don't care anything about resistance in

that sense. We get the practical result by measuring 10457
the volts or pressure and the candle-power in a photometer.

369 Q. Do you know approximately what was the difference between the resistance hot and the resistance cold of the paper carbons that you made in the latter part of 1879?

A. I really can't remember that now. I know it was different than the difference between bamboo as
made to-day. What that exact ratio was I do not re- 10458
member now. It could be easily determined.

370 Q. About what?

A. Well, I should say it came down forty-three per cent.

371 Q. Why do you fix upon forty-three per cent?

A. Because I know it came down more than present bamboo, and I think that comes down about thirty-three per cent.

THOMAS A. EDISON. 10459

10461

Defendant's Exhibit Edison's Canadian Affidavit.

THE ROYAL ELECTRIC COMPANY OF CANADA against EDISON ELECTRIC LIGHT COMPANY.	Petition on Patent of Canada, No. 10,654.

10462

BEFORE THE HONORABLE THE MINISTER OF AGRICULTURE.

STATE OF NEW JERSEY, } ss.:
County of Essex }

10463 THOMAS ALVA EDISON, being duly sworn, deposes and says as follows: I am 11 years of age; reside at Orange, New Jersey; and am the inventor named in the above patent, which was granted November 17th, 1879. My invention and patents relating to the subject of electric lighting, both for Canada and the United States, were sold long prior to the date of said patent No 10,654, to The Edison Electric Light Company, the predecessor of the above-named respondent. I have however, been a director of said respondent company
10464 and its predecessor company since the organization of such companies, and have always had a general knowledge of the business conducted by them, which has been the introduction into use in the United States and Canada of my inventions relating to electric lighting. I was in 1881, and have been ever since its organization, and am now, the President of The Edison Lamp Company, which has manufactured all of my lamps used in the United States under contract with

the respondent and its predecessor, The Edison Electric Light Company. 10465

The rights secured by my electric lighting patents in Canada, and especially those secured by my said patent No. 10,654, were considered extremely valuable both by myself and by the officers and directors of The Edison Electric Light Company, and are still so considered by the respondent company, the present owner of such patents. From the time of the beginning of the business, and soon after the granting of said patent No. 10,654, efforts were made to organize a large 10466
joint stock company which would undertake the active prosecution of the business in Canada, with ample capital and facilities, and with the intention of establishing a large manufacturing industry in Canada, and these efforts have been continued to the present time. The said patent No. 10,654 having always been and being still considered by us as our most valuable patent in Canada, covering as it does all incandescent electric lamps that have been put into commercial use 10467
up to the present time, we have recognized from the start the necessity for complying strictly with the provisions of the Patent Act as to manufacture and importation, in order to maintain said patent in force, and thus to preserve the value of the property which we have been trying to dispose of by the organization of a joint stock company as before stated.

Being only a director of the Edison Electric Light Company and not an officer of that company I was not in any way responsible for the carrying out of 10468
the provisions of the Patent Act with regard to said patent No. 10,654 and hence I am not acquainted with the details of the transactions with respect to said patent. I know, however, that during the year 1881 strenuous efforts were being made to organize a company in Canada, and that it was hoped from day to day to complete such an organization, the plan be-

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ing that such a company should establish the manufac-
turing business on a large scale, and that the manufac-
ture would be commenced within two years from
November 17, 1879, and thus be early enough to
maintain said patent No. 10,654. The completion of
the negotiations for such a company being deferred,
however, from time to time, it became apparent to
myself and the officers of The Edison Electric Light
Company during the latter part of October or early in
10470 November, 1881, that the manufacture of lamps in
Canada under said patent No. 10,654 would have to
be commenced at once in order to maintain said
patent. The officers of The Edison Electric Light
Company thereupon arranged with The Edison Lamp
Company, which was at that time and is still man-
ufacturing my lamps in the United States, for the
sending of men and material to Canada to com-
mence and carry on the manufacture of such lamps. I
was informed at the time and have always understood
10471 that these men commenced the manufacture of my
lamps under said patent No. 10,654 within two years
from the date of said patent. I also believe that such
manufacture has been carried on continuously since
that time and that the industry has grown to one of
considerable proportions, the factory being located at
present in the City of Hamilton, Province of Ontario.
So far as my knowledge, information and belief go no
incandescent electric lamps of any character, and espe-
cially no incandescent electric lamps embodying the
10472 invention of said patent No. 10,654 (except those sent
by me as models to the Canadian Patent Office, and
possibly a few lamps not exceeding half a dozen sent
to the Canadian factory as samples or standards for
testing other lamps by and never sold or intended for
sale), have been imported into Canada since the 16th day
of November, 1880, by myself or by my assignee or assig-
nees under said Patent No. 10,654 or by anybody auth-
orized either directly or indirectly by myself or my assig-

nee or assignees under said patent. I believe it was a year 10473
or more after starting the lamp factory in Canada be-
fore a single plant was sold. Nevertheless the manu-
facture was continued and a large stock of lamps was
accumulated, and the Canadian factory has always been
able to supply the demand for my lamps in Canada.

The lamp manufacturing business was established in
Canada by The Edison Electric Light Company at large
expense and has resulted in a large loss to that Com-
pany. It was carried on by that company until about 10474
November, 1883, at which time the plant was sold to
The Edison Lamp Company, which latter company has
continued to operate the factory and has invested a
large additional sum of money in carrying on the lamp
manufacturing business in Canada. During the two
years (from November, 1881, to November, 1883), that
The Edison Electric Light Company was operating the
lamp factory in Canada, the average cost of the lamps,
so I am informed, was between five and six dollars each,
while they were being sold at one dollar each. At the 10475
same time the Edison Lamp Company was manufac-
turing and selling the same lamps in the United States
for forty cents (40 cts.) each, and would have delivered
lamps at any point in Canada, duty paid for fifty cents
(50 cts.) each. Since November, 1883, to the present
time, under the management of The Edison Lamp
Company, the cost of manufacturing lamps in the
Canadian Lamp Factory has been materially reduced,
but it is still greater than the selling price of the same
lamps in the United States, and the lamps could be 10476
manufactured in the United States and delivered duty
paid at the factory in Hamilton, at a less price than the
cost of manufacture at Hamilton and still leave a large
profit to the United States lamp factory.

I understand that in carrying on the lamp manufac-
turing business in Canada, there have been imported
into Canada, glass bulbs, glass tubing, glass rods, cop-

10477 per and platinum wires and the carbon filaments as
they come from the furnaces in the factory of The Edi-
son Lamp Company at Harrison, New Jersey. The
glass parts mentioned are not manufactured by our lamp
factory in the United States, but are obtained from
glass manufacturers and principally from the Corning
Glass Works of Corning, New York. The Corning
Glass Works has also furnished these same parts for
the Canadian lamp factory. These glass parts are
10478 strictly of the character of raw material and in the shape
in which they are shipped from Corning both to the
United States and the Canadian lamp factory are use-
ful for the manufacture of many other articles besides
incandescent electric lamps, and are supplied to glass
blowers or bench workers as raw material for making
up into chemical glass ware and the like. I have been
informed that they have been manufactured and used
in the arts for many years before the invention of my
electric lamp. The copper and platinum wires are also
10479 an ordinary article of trade, useful for hundreds of pur-
poses besides lamp manufacture. Such wires are not
manufacured by the United States lamp factory, but
are purchased on the market in proper sizes by such
factory. Such wires and of the same sizes were ordin-
ary articles of commerce for many years before the in-
vention of my electric lamp.

The carbon filaments such as are imported into Can-
ada are only a partly manufactured article, viewed
from the standpoint of what has been considered as
10480 commercial in the art since prior to November, 1881
Such filaments are shipped to Canada in the condition
in which they come from the furnaces at the lamp
factory at Harrison, New Jersey, and after they are
placed in the lamp bulbs in the Canadian factory, the
process of carbonization is completed by the passing
of an electric current through them while a high va-
cum is maintained and thereby raising them to a heat

which is at least twice as high as that to which they 10481
are subjected in the furnaces. In the furnaces a white
heat is obtained which is below the melting point of
nickel, the result being the charcoaling of the bamboo
so that it will conduct the electric current. In the fin-
al process of carbonization, which is conducted in the
lamp bulbs, a heat is obtained which is above the melt-
ing point of platinum This heat is also at least twice
as high as the heat to which the filaments are brought
by the current in use, a 16-candle power lamp being 10482
raised to about 125 candles during the final process of
carbonization. This final carbonization which is con-
ducted in the Canadian lamp factory, reduces the fila-
ments to a pure carbon, decomposing as far as possible
the large amount of hydro-carbon remaining in the fila-
ments as they come from the furnaces. The furnace
carbonization is in fact only a preliminary step, mak-
ing the bamboo a conductor of electricity so that it can
be subjected to the final carbonization by the much more
intense heat of the electric current. The carbons as 10483
they come from the furnace would not make commer-
cial lamps as the art has existed since prior to Novem-
ber, 1881; they would change their candle power in use
requiring changes in current pressure in order to main-
tain the light at a predetermined standard, the high
vacuum necessary for long life and high economy of the
lamps would be soon destroyed, not only reducing the
life of the lamps below what would be considered com-
mercial in competition with lamps having carbon fila-
ments which had been properly carbonized, but also 10484
reducing the economy of the lamps while in use.

The final carbonization carried on in the Canadian
lamp factory, changes the character of the carbon fila-
ments, materially reduces their resistance, and makes
them practically unalterable under the conditions of
use, giving a high economy and long life to the lamps.

It has not been a question of cost of manufac-
ture which has brought about the importation of the

10485 carbons into Canada, since they have been furnished to the Canadian lamp factory at three cents each, and one filament only is used in each lamp, and even if the cost to make such carbons were several times in Canada what it is in the United States, they would still form only a trifling part of the cost of the completed lamps, and they would be made in Canada. We have recognized from the start that the importation of the carbons would be made a feature of any attack upon our
10486 lamp patents, and had it been practically possible to make the carbons in our Canadian lamp factory it would have been done.

The carbon filaments of my lamps are a pure, vegetable carbon, made by the carbonization of cane bamboo and without the addition by deposit of any mineral carbon.

My lamp factory at Harrison, New Jersey, I believe to be the only factory making a carbon of this character, and I consider the success and reputation of my
10487 lamp from a commercial point of view to be largely dependent upon the fact that I use such a carbon. Other manufacturers of incandescent electric lamps find it necessary to build up their carbons and cure their defects by depositing upon them a layer of mineral carbon obtained by dipping the carbons, when in the condition that they are in when received from the furnaces, in a hydro-carbon liquid, and then while they are immersed in the hydro-carbon liquid passing an electric current through them which decomposes the
10488 hydro carbon and deposits a layer of mineral carbon upon the filaments.

By long experience and the most careful and exhaustive investigations, I have been able to bring the process of preliminary carbonization in furnaces to such a state of perfection that a sufficiently large percentage of good carbons is obtained from the furnaces to enable me to make lamps having the pure vegetable carbons, which need no mineral deposit to make them

useful, and only require the process of final carbonization to perfect them for use. In order to make carbons of this character, however, the process of preliminary carbonization has to be conducted with great skill. The process is entirely dependent upon judgment as to proper heat at different stages and how long to maintain them, which conditions in turn are dependent upon and vary with conditions which cannot be stated, but can only become known to a person from long experience. It cannot be told whether the 10490
carbons are good or bad before they are taken out of the furnaces and tested. We have lost many large lots of carbons in carbonization, and at times we have entirely lost the art of carbonization, due to some failure in matters of detail which we could not discover. The commercial process is a most illusive one. We have at times carried on the process concurrently with regular observations as to the various atmospheric conditions of temperature, moisture, pressure and direction and velocity of wind; thinking that we might 10491
discover that the exact process was dependent upon some particular atmospheric condition. When we moved our lamp factory from Menlo Park to Harrison, New Jersey, and although I gave the matter considerable personal attention, it was some time before we succeded in making good carbons at Harrison.

The company at Paris which acquired my patents for the Continent of Europe, established a large lamp factory in France under the management of Mr. Charles Batchelor, the man who acted as my principal assistant throughout my experiments on the subject 10492
of electric lighting, and yet by reason of failure in carbonization, due to some slight but unknown difference in conditions, the lamps made in France for some time were commercially a failure. An enormous amount of money was spent by that company in its attempts to establish the art of carbonizing pure vege-

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table carbons, but after almost bankrupting the company by the expense, they were forced to resort to the hydro-carbon treatment in order to make a lamp at all commercial, and the lamps made by that company, to the present time have the treated carbons.

In the fall of 1886, complaints having been made
that the lamps manufactured at the factory at Harri-
10494 son, New Jersey, had greatly depreciated in quality, I
found it necessary to undertake personally the remedying of the difficulty. I moved my laboratory force and apparatus to the lamp factory and for about a year continued my investigations and experiments on the subject of carbonization. At first I could find no reason for the depreciation in the quality of the lamps, but by investigation it finally appeared that some slight but theretofore unnoticed changes had been made in the carbonization and by going back to a strict observation of our former practices the difficulty was
10495 remedied.

The company located at Berlin, Germany, which purchased the patents on my lamp for Germany from the company located at Paris, established a large lamp factory under the direction of Mr. James Hipple, who went from my lamp factory in this country and was a man of large experience in lamp manufacturing methods. Furnaces were set up and an attempt made to manufacture lamps having pure vegetable carbons, but
the same difficulties were experienced as had been ex-
10496 perienced by the French company, and the lamps were
a complete failure from a commercial point of view. The German company was obliged to resort to the hydro-carbon treatment of the carbon filaments notwithstanding the fact that they employed the best obtainable talent and expended a large amount of money in endeavoring to make the pure vegetable carbons. The lamps made by that company are to this day provided with carbons having the mineral deposit produced by the hydro-carbon treatment.

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Our experience has shown us that had we persisted in our endeavor to carbonize pure vegetable carbons in Canada, it would have been necessary in order to make it successful for me to go personally to Canada with the carbonizing force of our United States factory and to stay there fostering the process, which would have resulted in the serious crippling of our lamp manufacturing business in the United States. We did some carbonizing in Canada and sent there all the ma-
terials for a large furnace, but we then clearly saw that 10498
the whole business would be cast into dispute by the uncommercial lamps which would be produced should we continue to carbonize there. I have not the least doubt that the carbonizing of our carbons in Canada, without my personal attention and that of the carbonizing force of the United States factory, would have resulted in the entire abandonment of our lamp manufacturing business in Canada, and had we not imported our carbons into Canada, our lamp-manufacturing
business there could not have been established. We 10499
would have been forced to give up our Canadian patents and to manufacture all our lamps for the Canadian market in the United States. As a confirmation of my view, I am informed that no other electric lighting company has manufactured incandescent electric lamps in Canada but that all such lamps except those of my own manufacture are imported into Canada.

I have had my attention called to the reasons given in the application made by Mr. Coursolle for an ex-
tension of the time within which to commence manu- 10500
facture under said patent No. 10,654. The matter was in the hands of the attorneys for The Edison Electric Light Company and I had nothing to do with it personally. The reasons which were given by Mr. Coursolle were not suggested by me so far as I can now remember. They were, however, entirely true. Our plan had been to organize a large company and go into the manufacturing business on a large scale in Can-

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ada, as I have before stated, and it was only at the last moment and in order to protect the patents that we concluded to begin on a smaller scale. The plans we had for the Canadian business required large amounts of money, and it was undoubtedly that view of the matter which was represented by Mr. Coursolle to the proper person in the office of the Commissioner of Patents. In the summer of 1887 I had complete working drawings and specifications prepared under my per-
10502 sonal direction by an architect for the building of a large lamp factory in Canada, and I was about to send a representative to Canada to purchase a site and start the construction of the buildings, but being told by the counsel for the respondent that my lamp patents were threatened with attack before the Honorable Minister of Agriculture, I postponed the carrying out of my plans in this respect. I have been urged by the officers of the respondent company and the counsel for that company to appear before the Honorable Minister
10503 of Agriculture at the hearing of the above petition and testify orally. I am very desirous of doing so, but the demands upon my time are so great that I fear I will not be able to do so. I have now employed on my personal experimental work upwards of one hundred men, who look to me hourly for instructions, and I am conducting a number of most important experiments requiring my constant attention. I have been obliged lately to work far into the night, and frequently all night on these experiments, and such large interests are
10504 dependent upon their success that I do not see how I can well leave my laboratory for the length of time which would be required for giving my testimony in Ottawa.

Subscribed and sworn to before me,
this day of November, 1888.

Is is stipulated that the foregoing document is a correct copy of the original affidavit of Thomas A. Edison, verified by him in November, 1888, and used in the proceedings in Canada instituted by the Royal Electric Company against the Edison Electric Light Company, and that it may be used with the same force and effect as the original might be. 10505

Richard N. Dyer,

Of Counsel for Complainant. 10506

10509
Defendant's Exhibit Edison Caveat, December 22d, 1879.

Copy of Caveat of Thomas A. Edison, No. 93, Improvement in Electric Light, Dated December 17th, 1879, Filed December 22d, 1879.

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo
10510 Park, in the State of New Jersey, have invented an
improvement in electric lights, of which the following
is a specification:

The object of this invention is to produce carbon conductors of high resistance to produce the electric light by incandescence.

One of the materials which I employ, is made by
taking common lampblack and subjecting it to high
heats in a closed crucible; afterwards this lampblack
10511 is mixed with tar until it is quite sticky. It having
been well mixed, more lampblack is added from time
to time until it becomes of a consistency that it can no
longer be worked in by a spatula or in a mortar. It is
then pounded in by beating and turning until it has
just sufficient plasticity to allow of being rolled out on
a flat plate; to do this a small piece is rolled by the
finger until it is in the form of a cylinder or wire; it
is afterwards rolled out to the proper length and thick-
ness by placing it on a wide, flat piece of wood and
10512 rolling it back and forward.

When it has reached the proper shape it is dusted over with a powder which is non-carbonizable, this prevents its sticking to any substance which it may come in contact.

A mandril has upon it a copper spiral composed of ribbon wound or made with its edges outward like a washer.

The plastic carbon wire is wound between the turns

of this copper spiral, and the latter is pressed to- 10513
gether, thus flattening the side of the plastic carbon
and giving it the same shape as the copper spiral.
The ends of the plastic carbon is then secured to
platina wires, by adding an excess of the plastic ma-
terial at the point where the platina wire is inserted in
the plastic carbon, the wires and copper spiral is then
clamped in a proper frame work, the mandril is with-
drawn, and the former placed in a sealed iron tube
and subjected for a few minutes by a gradual in- 10514
crease, to a white heat, the volatile part of the tar be-
ing driven off and the remainder carbonized, locking
the lampblack particles finely together, and making a
stiff spiral. While being carbonized the plastic ma-
terial shrinks considerably, and this is the main diffi-
culty of the operation of manufacturing, and I am
now engaged in perfecting the mode of making so as
to produce these spirals cheaply. After carbonization
the copper spiral is eaten away by nitric acid, leaving
only the carbon with its platina wires. The latter 10515
have by the act of carbonization become firmly at-
tached to the carbon, so much so that it is with diffi-
culty that they can be detached, and the resistance
of contact between the carbon and metal is much low-
er than it would be if the carbon was pressed against
the platina by a clamp with sufficient power to
break the frame.

One reason why platina moulded in the carbon
makes a superior contact is, that contraction during
carbonization produces a powerful pressure between 10516
the carbon and platina, and another reason is, that at
the white heat of carbonization platina is attacked
and combined with the carbon.

Thus by this discovery I am enabled to obtain a good contact between the carbon and leading wire without the necessity of clamps, which, with so fragile a substance, would be very difficult if not impracticable with the ordinary method of manufacturing car-

10517
bon, this difficulty is not so great as the carbons are
made very homogeneous by the use of hard carbon
particles and the several dippings and carboniza-
tions which they undergo to make them more solid
and of low resistance.

A spiral of carbon formed of lampblack looks far
more homogeneous under the microscope than a carbon
rod made in the ordinary way, but which has at least
ten times the weight of the frame. My great object is
10518 the production of a carbon wire of the highest possible
resistance, that will have an even resistance, as I have
discovered, no matter how fine the carbon is, if placed
in a vacuum exhausted to the one-millionth of an
atmosphere, that this space is sufficiently void of oxygen
to cause the conductor to be absolutely stable.

By means of coiling the plastic carbon in the form
of a spiral, I am enabled to use a greater length of
carbon, and of greater mass without unnecessarily in-
creasing the radiating surface.

10519 Thus I can use a more homogeneous carbon and
have a higher specific heat given the lamp, thus
lengthening to cooling time of the same, and make it
less responsive to changes in the strength of the cur-
rent. By this means I obtain a lamp of sufficient high
resistance to allow of the subdivision of the electric
light practically by placing the lamps in multiple arc.

The resistance of the plastic carbon may be in-
creased by mixing with it, while plastic, powders which
are volatile, such as camphor powder, or powders which
10520 are at first bulky, afterwards shrink, such as starch.
Zinc oxide may be used, as this becomes volatile at a
high temperature, unignited lampblack, which is less
compact, may also be used; even retort carbon may be
used, but it should be finely ground and mixed with
some non-conducting substance to separate the parti-
cles; otherwise it would be of such low resistance as
to require a great length to obtain the requisite re-

10521
sistance and a consequent increase in the radiating
surface, and hence loss of energy. A bobbin of plastic
carbon may be formed by winding within the copper
spiral one layer, and covering the whole with paper
over which another copper spiral is placed, into which
a second layer is wound. The copper spiral might be
dispensed with, and the plastic carbon first coated
with chalk or starch, is wound in one or more layers,
one over the other, upon a mandril which is after-
wards withdrawn, the whole subjected to carbonization, 10522
after which the carbon wire is sufficiently stiff to hold
its position, each turn being separated from the other
by the shrinkage of the chalk, or the destruction of
the starch, thus by several layers one within another,
large conductors and greater lengths, and therefore
greater mass may be used without lowering the resist-
ance or increasing the radiating surface. The plastic
carbon, with tar, may be mixed with powdered vege-
table fibre, to allow of it being handled without
stretching, or a thread may be used, the whole coated 10523
with the plastic lamp-black and rolled out, the thread
allows the whole (even when the mass of carbon
around it is great) to be handled without fear of
stretching, an iron wire might be used and thickly
covered with the plastic material and carbonized, the
shrinkage would of course, produce cracks, but these
could be rubbed full of plastic carbon, and the whole
spiral re-carbonized with its platina contacts; after-
wards the iron wire could be eaten out by acids—even
platina wire might be used. 10524

Spirals and different forms of burners may be ob-
tained by carbonizing vegetable fibre, such as wood,
cotton, &c. If a thread is secured to the platina wires
by a little of the plastic carbon, and the whole clamped
and subjected in a closed chamber to heat, the thread
and plastic material will be carbonized and become a
conductor; one-half inch of thread will offer a resist-

10525 ance generally of one hundred ohms, but of course, the resistance will be variable as a whole, and in different parts of so small and light a carbon, hence it is better to increase the conductivity and length to enable one to obtain lamps having nearly the same resistance. One inch of cord composed of eight of the finest threads is well worked with the plastic lampblack rolled and secured to the platinum conductors as hereinbefore described.

10526 This, after carbonization, is sufficiently strong for practical use, but has only a resistance of twenty ohms, hence a greater length than one inch is necessary to obtain one hundred ohms, and to prevent a great increase in the radiating surface it must be coiled or otherwise arranged.

This conductor, if placed in an ordinary vacuum chamber, is consumed in a few minutes, but if sealed in a glass bulb and the air exhausted by a Sprengel pump, provided with a chemical drying tube filled
10527 with either sulphuric acid or phosphoric anhydride, and a tube with finely divided copper for absorbing mercury vapor, and the exhaustion carried to a point where the McLeod gauge shows the pressure to be at least $\frac{1}{500,000}$ of an atmosphere, the carbon may be brought up to a point where, although giving a light of three gas jets, is absolutely stable, notwithstanding its fragile nature. Paper may be substituted for the thread. Vulcanized fibre, which is paper, may be used. A spiral may be sawed out of this fibre or of
10528 wood and used, the contacts with the platinum wires being made by the use of the plastic carbon.

In fact, any substance which will give a framework of carbon, when subjected to heat within a closed vessel may be used.

I am now engaged in perfecting a method for the

rapid and economical manufacture of these conductors, which will be the subject-matter of patent application. 10529

Signed by me, this 17th day of December, A. D. 1879.

(Signed) Thomas A. Edison,

Witnesses:

Samuel D. Mott.

S. L. Griffin.

10530

Admitted to be a correct copy of the caveat filed by Thomas A. Edison in the U. S. Patent Office Dec. 22, 1879, may be used with same force and effect as the original could be.

RICHARD N. DYER,

Of Counsel for Complainant.

10533

Defendant's Exhibit, Foussat Article.

The Electrician, published at London, January 31, 1885, Vol. 14, page 246.

INCANDESCENT LAMPS.

To the Editor of the Electrician :

SIR: I don't know whether it is that my knowledge
10534 of English is deficient, or that "Carbon" (in your last number), has put his query in a very involved form. If he is simply seeking information as to the comparative duration of incandescent lamps run *over* and *below* their "normal" candle-power, I beg to offer him the following average of a very extended series of tests made in the Edison Manufactory, Ivry, near Paris. The lamps were Edison's 16-candles, 100 volts:—

At 100 volts average life of lamps was 1,000 hours.
" 99 " " " " " 1,277 "
10535 " 98 " " " " " 1,645 "
" 97 " " " " " 2,135 "
" 96 " " " " " 2,751 "
" 95 " " " " " 3,595 "

On the other hand, running the lamps at an increased power, we obtained the following results:

At 100 volts average life of lamps was 1,000 hours.
" 101 " " " " " 785 "
" 102 " " " " " 601 "
10536 " 103 " " " " " 477 "
" 104 " " " " " 375 "
" 105 " " " " " 284 "

Other than Edison's lamps, of which we tested considerable numbers, gave almost identical results.

Yours, &c.,

G. FOUSSAT.

8 Bernard street, W. C., London, 29th January, 1885.

Defendant's Exhibit, Siemens Article. 10537

The Telegraphic Journal and Electrical Review, London, Dec. 19th and 26th, 1885, Vol. 17, pages 514-516 and 531-533.

ON IMPROVEMENTS IN GLOW LAMPS.

BY WILHELM SIEMENS.

In the *Elektrotechn Zeitschrift*, Vol. IV., page 331, 10538
there appeared a table containing the characteristic regarding the then new glow-lamps of the firm of Siemens and Halske. To this table were appended certain explanatory remarks in which the advantages of the new lamps were set forth. A proof was given, indirectly at least, that the augmented efficacy of these lamps was attained not by an increase of temperature injurious to their durability, but by a more judicious treatment of the carbon filaments.

The experience subsequently acquired has merely 10539
confirmed the results and views which had then been acquired. The method employed has not merely been retained, but its further development, in which I have to make especial mention of the activity of Herr A. Heller, has led to new and important results.

I give in the following table a conspectus of the types of glow-lamps now manufactured by the firm of Siemens and Halske.

TABLE I. 10540

Name of Types.	IA.	I.	II.	II.	IV.	IV	IV.	IV.	VI.	VI	VI.	VIII.	X.
Light in Normal Candles.... ...	.5	8	10	10	16	16	16	16	25	25	25	35	50
Normal Tension in Volts	.25	50	100	65	120	100	65	50	120	100	65	100	100
Current in Amperes..........	0.77	0.55	0.39	0.54	0.50	0.53	0.77	1.06	0.75	0 77	1.17	1.12	1.50
Resistance (hot) in ohms....	32.7	90 9	256	120	260	189	84.4	47.2	160	130	55.8	89.3	66.6

As the unit of light, the English spermaceti-candle has been selected, as is customary. According to the

10541 check-measurements performed, it consumes hourly,
and with a flame of 45 millimetres in height, 7.8 grm.
of spermaceti. This loss of weight agrees with other
statements. The normal candle is not employed for
the current measurements of light, but serves only for
the photometry of a glow-lamp selected as a standard
light. Its tension is then noted, and is kept exactly
constant in subsequent measurement. This standard
lamp, however, if in continual use, must be compared
10542 daily with the normal candle, and must be re-adjusted
if necessary, since its light gradually decreases even at
constant tensions.

Several Siemens & Halske torsion-galvonometers
were used for measuring the current and the tension.

In order to exclude any inaccuracy of the measurements, springing from a possible variation of the instruments, they were compared with a silver voltameter every fortnight in regular rotation. They were also compared daily among themselves.

10543 It may, however, be said, that in spite of the con-
tinual use of these instruments for several years, no
re-adjustment was found necessary. At the utmost, the
table of corrections had to be modified to the extent
of half per cent.

To avoid misunderstandings, it may be remarked
that the luminous strength of the lamps as here given,
signifies their mean horizontal luminous intensity. The
measurement of the mean spherical luminosity; which
is in itself more accurate, was not carried out on the
10544 ground of convenience. Moreover, the mean horizon-
tal strength of light is exclusively used in practice for
glow-lamps. Repeated experiments have shown satis-
factorily that in the Siemens & Halske lamps, which
have carbon filaments of a circular section, one meas-
urement at any angle around the vertical axis is suffi-
cient, and is identical with the mean horizontal
strength of light. In the Edison lamps, where the
filaments are of a rectangular section, it is sufficient to

execute measurements at two different angles around 10545
the vertical axis, and to take the mean of both. For
the first measurement the lamp is placed so that the
two halves of the filament almost cover each other,
and for the second, so that the plane of the filament
is about at right angles to the axis of the photometer.

A circumstantial discussion of the data given in Ta-
ble I., would be foreign to the purpose of these com-
munications. It may be briefly mentioned that the
favorable results contained in the earlier table above 10546
mentioned, as regards the small consumption of energy,
and the high resistance of the lamps, re-appear in this
new table, and, indeed, partially to an increased ex-
tent. Attention may also be called to the relatively
very high resistance of the 16-candle lamp at 120 volts,
the use of which, e. g., for central stations would ad-
mit of a considerable economy in the heavy costs of
the system of conductors. This lamp, as well as the
types at 65 volts, are especially arranged for installa-
tions in which glow-lights or arc lights are worked by 10547
the same machine and with one common circuit, which
has latterly come into much request. The latter tension
in the circuit is requisite when the arc-lamps (those of
3, 6, 9, 20 or more ampéres at pleasure) burn singly,
parallel with the glow-lamps. The former tenson is
requisite when the arc-lamps are arranged by twos in
succession.

I come now to the method upon which the manufac-
ture of the Siemens and Halske glow-lamps depends,
and the application of which permits such important 10548
progress.

The method, in itself, is not novel. It consists, in
general terms, in a treatment of the carbon filaments
in suitable hydro-carbons, and it seems to have first
been used by Maxim and Sawyer-Man. As I have pre-
viously intimated (Elektrotechn, Zeitschrift, March,
1883, p. 114), the production of gas retort coke has an

10549
analogy to this treatment of the filaments. As here, the particles of carbon from the hydro carbons are deposited on the heated filament, so in the former case a thick, firm layer of carbon is deposited on the hot sides of the iron retort—the so-called retort carbon. By means of this process, which, without doubt, is in a more or less successful manner the foundation of many modern glow-lamps, it was thought that a greater solidity of the filaments might be attained, and on the
10550 other hand, it proved a convenient means for adjusting the lamps with great accuracy to given resistances.

In the treatise already referred to (in the August issue of the Elektrotech. Zeitschrift for 1883), I did not enter closely upon the manner of producing filaments on the principle just named. It was, however, distinctly laid down that the main advantage of the new lamps consisted in an improved superficial substance of the carbon filaments, permitting a more favorable emission of light. But that by a correct preparation
10551 of carbon filaments in hydro-carbons we might arrive at a more economical quality of eradiation, was a new and certainly not unimportant observation, since in this manner it became possible to produce about one-third more light with the same expenditure of energy, or to work one-third as many more 16-candle lamps than would be possible without this process.

It must be admitted that there is still much scepticism concerning this fact, and that it has remained to a great extent unnoticed. This may be explained by
10552 the circumstance that the preparation of the filaments in hydro-carbons does not at once, and as a matter of course, lead to the desired results. I may remind the reader of the observation communicated in Vol. IV., p. 114, of this journal (Elektrotech. Zeitsch.), made on some lamps manufactured on the Maxim process. If these lamps were allowed to burn for any length of time at a constant tension, there was found, even in a few hours, a very notable decrease of light, until finally

the lamps burnt quite red. Although even then this 10553
defect could be obviated to a certain extent, the results attained were, upon the whole, unfavorable. It seemed, therefore, more advantageous to use carbon filaments without any preparation, as was done in the earlier Siemens and Halske lamps.

Continued experiments gave finally so satisfactory results that there was no objection to the introduction of the above process into the manufacture, and in the August issue of this journal for 1883, the most favor- 10554
able data concerning the new lamps could be communicated.

In consequence of the great sale of these lamps, certain experiences and observations were met with in course of time which in the laboratory or in a restricted use might have escaped notice. The practical use of a lamp alone can decide whether it is in all parts correctly combined. An important point, on which practice is expected to supply the decision, is the question of durability. Weighty as is this matter, its value is often 10555
exaggerated. A reduction in the temperature of the carbon filaments gives a very easy means of prolonging the life of the lamps indefinitely, though at the cost of economy in other respects. We have here a simple question of expense. In opposition to the cost of procuring the lamps comes the cost of the energy expended in them, and, in the present posture of things, it is more important and economical to reduce the expenditure of energy as far as possible, rather than to prolong their durability beyond 800—1,000 hours. 10556
Such comparative calculations have been repeatedly undertaken, e. g., at least in a certain sense, by Prof. Dr. Dietrich.

As the basis of his computations he takes the table given by Herr Zacharias in the Wiener Zeitschrift fur Elektrotechnik (May 15th, 1884, p. 275), showing the durability of the Edison glow lamps when used, not

10557
with their normal tensions, but with greater or smaller ones.

Though Professor Dietrich makes the justifiable reservation that many of the values given seem to him to have been found by interpellation, he considers that a calculation sufficiently approximative for his purpose may be based upon these data.

Against this there is not much to object, if a circumstance of much importance had not been overlooked
10558 and which has not yet received due attention. It is known that all glow-lamps on prolonged use become somewhat coated, and thereby gradually lose their strength of light. As far as I am aware, the magnitude of this loss and its exact progress have not been at all taken into account.

Many experiments on this subject, conducted in the establishment of Siemens and Halske, have afforded strict proof that we have here a great and general de-
10559 fect of the glow lamp. It has been found that glow lamps after prolonged normal use, e. g., for 800 hours, suffer a far greater loss of light, and a far greater decrease of the useful effect, as compared with its initial quantity than might have been expected according to common belief.

The experiments were made in the first place on the Siemens & Halske glow lamps, prepared as heretofore. At first it was feared that there was here a peculiar and inevitable defect of the filaments prepared
10560 in hydrocarbons. It could not be denied that these lamps on prolonged use gave out a decidedly duller light than lamps with unprepared filaments. This unfavorable impression was, in part, due to the circumstance that the coating in those lamps had a blackish appearance, whilst in the Edison lamps it took a more brownish character, so that the semblance was worse than the reality.

In any case it was a matter of pressing necessity to

make essential progress in this direction. From the 10561
tables and curves given below, it will be seen that the trouble has not been in vain. I cannot give in detail the single stages of the essentially modified and improved process, according to which the Siemens and Halske lamps are now produced. The changes extend almost to every part of the manufacture, so that in reality a quite new lamp has sprung from these experiments. A particularly essential condition of success lay in the production of a vacuum as nearly perfect as 10562
possible. A step forward in this direction is especially Siemens and Halske's patent method of connecting the carbon filaments with the platinum wires. It thus became possible to omit entirely the thickened ends of the carbons, which are so difficult to free from the last traces of air. The connection is now effected by laying the flattened ends of the platinum wires in narrow spirals round the ends of the carbon, not thickened. To effect an intimate connection between platinum and carbon, the point of contact is covered with a galvanic 10563
deposit of copper or nickel. It is a condition that the upper turns of the platinum spirals where they lie next to the ignited carbon must remain free from the galvanic deposit. In this manner it is rendered possible that the platinum, in spite of the immediate proximity of the ignited carbon, may not become incandescent, and all danger of volatilization is avoided.

In order to show the results obtained I give below some tables, illustrated by diagrams, which represent the results of prolonged experiments carefully exe- 10564
cuted. These experiments extended, in the first place, only to 16-candle lamps at about 100 volts. The lamps were daily in continuous action for about 9 hours. As it was very important to maintain a constant difference of tension at the lamps during the whole time of the experiments, and in order to eliminate as far as possible any irregularities in the movements of the

10565 steam engine an apparatus was introduced into the circuit which maintained automatically an approximately uniform tension in the lamps by the insertion and removal of a resistance into the machine. The greatest difference of tension, transitorily observed in momentary fluctuations of the machine, was 3 volts.

The experiments were made with prepared (on the new Siemens and Halske process) and unprepared filaments, and a specifically different behavior of these
10566 two kinds of lamps was distinctly observed. It cannot, indeed, be maintained with certainty that the different behavior of these lamps can be entirely referred to the difference in the carbon filaments. For though it would have been, strictly speaking, the most correct thing to make both kinds of lamps absolutely alike in all other respects, this idea had to be renounced in order to avoid other and perhaps greater sources of error. For the correct treatment of a new material can only be gradually found on the basis of prolonged
10567 and varied experience, and such experience was not at command with reference to the unprepared carbon filaments. It seemed, therefore, most suitable to use for this part of the experiments American Edison lamps which have a filament of carbonized bamboo fibre of a rectangular section.

The measurements extended over a time of 800 hours, and were executed at intervals of 100 hours as regards strength of light, strength of current and tension.

10568 Table II. contains measurements made on groups of 10 lamps respectively with prepared and unprepared filaments. The values given are the means of the measurements of each such group. The lamps burned during these experiments at their normal tension, at which they are supposed to give the light of 16 candles.

TABLE II. A.—LAMPS WITH UNPREPARED FILAMENTS. 10569

Time of burning in hours.	Tension in volts.	Current in ampères.	Strength of light in normal candles.	Normal candles per electric horse-power.	Remarks.
0	96	0·710	19·9	215	One lamp burst in 50 hours; 1 lamp burst in 280 hours; 1 burnt out in 650 hours; the remaining 7 still exist.
100	„	0·674	15·7	178	
200	„	0·656	14·3	167	
300	„	0·654	13·8	160	
400	„	0·650	13·2	155·5	
500	„	0·636	13·0	155	
600	„	0·632	13·2	148	
700	„	0·630	11·1	135	
800	„	0·630	11·0	134	

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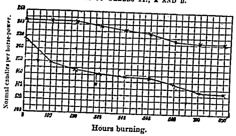
DIAGRAM TO TABLES II., A AND B.



10571

Hence it appears that the greatest difference in the power of the light amounts to 8.9 candles, and that the lamps burned for the 800 hours with a mean value of 13.58 candles and a mean effect of 159.1 normal can-
dles per electric horse-power. At the conclusion of 10572
the measurements the effect was only 62.3 per cent. of its original value; the strength of light had fallen to 55.3 per cent. of its initial amount, whilst the resistance (hot) had increased by 12.7 per cent.

10565

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The experiments were made with prepared (on the new Siemens and Halske process) and unprepared filaments, and a specifically different behavior of these
10566 two kinds of lamps was distinctly observed. It cannot, indeed, be maintained with certainty that the different behavior of these lamps can be entirely referred to the difference in the carbon filaments. For though it would have been, strictly speaking, the most correct thing to make both kinds of lamps absolutely alike in all other respects, this idea had to be renounced in order to avoid other and perhaps greater sources of error. For the correct treatment of a new material can only be gradually found on the basis of prolonged
10567 and varied experience, and such experience was not at command with reference to the unprepared carbon filaments. It seemed, therefore, most suitable to use for this part of the experiments American Edison lamps which have a filament of carbonized bamboo fibre of a rectangular section.

The measurements extended over a time of 800 hours, and were executed at intervals of 100 hours as regards strength of light, strength of current and tension.

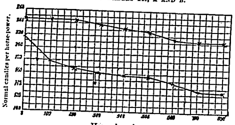
10568 Table II. contains measurements made on groups of 10 lamps respectively with prepared and unprepared filaments. The values given are the means of the measurements of each such group. The lamps burned during these experiments at their normal tension, at which they are supposed to give the light of 16 candles.

TABLE II. A.—LAMPS WITH UNPREPARED FILAMENTS. 10569

Time of burning in hours.	Tension in volts.	Current in ampères.	Strength of light in normal candles.	Normal candles per electric horse-power.	Remarks.
0	96	0·710	19·9	215	One lamp burst in 50 hours; 1 lamp burst in 280 hours; 1 burnt out in 650 hours; the remaining 7 still exist.
100	"	0·674	15·7	178	
200	"	0·656	14·3	167	
300	"	0·654	13·8	160	
400	"	0·650	13·2	155·5	
500	"	0·636	19·9	155	
600	"	0·632	12·2	148	
700	"	0·630	11·1	135	
800	"	0·630	11·0	184	

10570

DIAGRAM TO TABLES II., A AND B.



10571

Hence it appears that the greatest difference in the power of the light amounts to 8.9 candles, and that the lamps burned for the 800 hours with a mean value of 13.58 candles and a mean effect of 159.1 normal candles per electric horse-power. At the conclusion of 10572
the measurements the effect was only 62.3 per cent. of its original value; the strength of light had fallen to 55.3 per cent. of its initial amount, whilst the resistance (hot) had increased by 12.7 per cent.

10573

B.—Lamps with Prepared Filaments.

Time of burning in hours.	Tension in volts.	Current in ampères.	Light in normal candles.	Normal candles per electric horse-power.	Remarks.
0	96	0·550	17·5	244	At the conclusion of the experiments all the 10 lamps were still in existence.
100	,,	0·550	17·5	244	
200	,,	0·550	17·5	244	
300	,,	0·544	17·0	239	
400	,,	0·544	16·5	232	
500	,,	0·540	15·9	225	
10574 600	,,	0·535	15·05	215	
700	,,	0·528	14·5	213	
800	,,	0·528	14·5	213	

The greatest difference in the strength of the light is here three candles. The lamps burnt with a mean intensity of 16.24 normal candles and a mean useful effect of 230.1 normal candles per electric horse-power. The useful effect declined in the course of the 800 hours to 87.3 per cent., and the intensity of light to 82.9 per cent. of its initial value. The increase of re-
10575 sistance amounted to 4.2 per cent.

These results are illustrated by the curves in diagrom II. The hours of burning are taken as abscissae, and as ordinates the number of normal candles produced by an electric horse-power. The upper curve shows the results with prepared, and the lower curve with unprepared filaments. The crosses on the lower curve marked the spot where a lamp has burst.

The form of the curves shows a characteristic difference in so far as with unprepared filaments the effect
10576 in the first portion of the time declined comparatively rapidly, whilst at the same point the prepared carbons were far more constant.

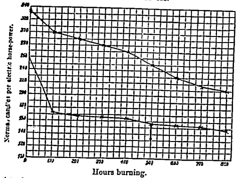
It was now important to examine how the two kinds of lamps would behave if the experiments were made with a higher initial effect. Ten of each kind were again set in action, all the twenty being supplied by one common circuit. In the following table III., the mean values are given.

10577

Table III. A.—Lamps with Unprepared Filaments.

Time of burning in hours.	Tension in volts.	Current in amperes.	Light in normal candles.	Normal candles per electric horse-power.	Remarks.
0	100	0·687	24·25	259	After 15 hours 1 lamp burnt out; the remaining 9 were still in existence at the conclusion of the experiments.
100	100	0·666	15·7	173	
200	100	0·666	15·3	169	
300	100	0·664	15·2	167	
400	100	0·653	14·7	165	
500	100	0·640	13·7	157	
600	100	0·634	13·3	154	
700	100	0·630	13·1	153	10578
800	100	0·620	12·5	148	

Diagram to Table III.



10579

At the conclusion of this experiment, the useful effect had fallen to 57.1 per cent., and the strength of 10580
light to 51.5 per cent. of its original value. The greatest difference in the strength of the light amounts to 11.75 candles; the mean light during the 800 hours was 14.94 candles; and the mean useful effect 167.7 normal candles per electric horse-power. The increase of resistance was 10.8 per cent.

If these results are compared with those in Table II. A, the latter, in spite of the somewhat smaller use-

ful effect must be regarded as more favorable, because
the decrease of the light is not merely smaller but con-
siderably more regular.

B.—LAMPS WITH PREPARED FILAMENTS.

10582

Time of burning in hours.	Tension in volts.	Current in ampères.	Light in normal candles.	Normal candles per electric horse-power.	Remarks.
0	100	0·552	25·0	333	All the ten lamps in existence at the conclusion of the experiments.
100	100	0·550	22·5	300	
200	100	0·550	22·0	290	
300	100	0·548	21·0	282	
400	100	0·547	20·0	270	
500	100	0·545	18·6	251	
600	100	0·545	17·1	230	
700	100	0·540	16·0	218	
800	100	0·532	15·3	210	

Here the greatest difference in the strength of the
light is 9.7 candles: the increase of resistance is 3.8
10583 per cent; the mean strength of light during the exper-
iment was 19.67 candles, and the mean useful effect
per electric horse-power 264.1 candles. After burning
for 800 hours, the useful effect retained 63.1 and the
strength of light 61.2 per cent. of its original value.

The diagram to Table III. illustrates these relations
in the same manner as was done above in Diagram II.

On comparing the curves II. B and III. B (prepared
filaments) it appears in the first place that in the latter
(where the initial useful effect is 340 normal candles
10584 per electric horse-power) we obtain a better mean use-
ful effect than in the curve II. B where the useful ef-
fect begins with 244 candles per horse-power. The
mean useful effects are as 264.1; 230.1, or as 100:
87.1.

The curve II. B is, however, characterised by a far
greater constancy and uniformity. Even if we overlook
the circumstance that lamps prepared according to the
curve II. B, would last much longer than lamps made
after III. B, the firm, Siemens and Halske, must doubt

that the former (in accordance with curve II.) are the 10585
more rational, since a fall of the strength of light down
to 61 per cent. of the initial value is inadmissible in
practice. The circumstance is peculiar that during the
same time of activity (800 hours), the increase of re-
sistance in the more intensely heated lamps (Tables
III. A and III. B) is less than in the less heated lamps
(Tables II. A and II. B). It follows that the decrease
of the strength of light in the former case depends to a
greater extent upon coating than it does in the latter. 10586
The principal cause, however, of the decrease of light,
is in all cases the increase of resistance.

The curves II. A and III. A (unprepared filaments)
strike us in the first place by their peculiarly irregular
course. It is surprising that in spite of the very dif-
ferent initial values of the useful effects after burning
100 hours, they reach a tolerably complete approxima-
tion. In both cases, the effect after 100 hours was
rather less than 180 candles per electric horse-power,
whilst the corresponding initial values were 260 and 10587
220. For the further explanation of these circum-
stances, it seemed desirable to examine the behavior of
such lamps at higher temperatures, or with higher ini-
tial effects.

This experiment was conducted with 10 lamps, the
means of the measurements of the single lamps being
given in the table. As the point here was to examine
the initial behavior of the lamps, the experiments were
closed after the lapse of 100 hours. The measurements 10588
were made every 10 hours.

10589

TABLE IV.—UNPREPARED CARBONS.

Burning in hours.	Tension in volts.	Current in amperes.	Light in normal candles.	Normal candles per electric horse-power	Remarks.
0	115	0·863	44·2	328	One lamp burnt out after 11¼ hours; 1 after 22 hours; 1 after 26 hours; and 1 after 85 hours. The remaining 6 still in existence.
10	115	0·817	38·5	303	
20	115	0·808	33·5	265	
30	115	0·806	31·5	251	
40	115	0·806	29·1	231	
50	115	0·806	26·4	209	
60	115	0·806	26·0	206	
70	115	0·806	25·3	201	
80	115	0·801	24·1	192	
90	115	0·793	22·8	181	
100	115	0·795	20·7	175	

10590

DIAGRAM TO TABLE IV.

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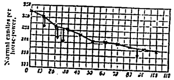


Hours burning.

The four arrows pointing downwards show the times when a lamp burnt out.

The course of the curve IV. shows that, in this case also, the useful effect declined after about 100 hours to the same amount as in II A., and III. A.

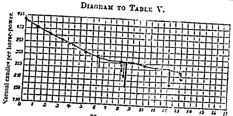
Finally, in a last prolonged experiment the course of the curve V was ascertained at a high initial effect.
10592 The corresponding table V shows the mean of the measurements of 6 lamps. The duration of the lamps, in accordance with the higher temperature of the filaments was very brief, as by the end of 13 hours the last of them was burnt out. The measurements were made hourly.

TABLE V.—LAMPS WITH UNPREPARED FILAMENTS. 10593

Burning in hours.	Tension in volts.	Current in ampères.	Light in normal candles.	Normal candles per electric horse-power	Remarks.
0	123	0·932	68·4	438	One lamp burnt out in 6 hours 12 minutes; another in 8 hours 6 minutes; another in 8¼; a fourth in 8 hours 20 minutes; a fifth in 12 hours 12 minutes, and the last in 13 hours 4 minutes.
1	123	0·929	64·6	412	
2	123	0·929	60·4	386	
3	123	0·930	56·9	360	
4	123	0·924	49·9	323	
5	123	0·922	45·1	293	
6	123	0·924	42·8	277	
7	123	0·910	39·9	262	
8	123	0·907	38·9	257	
9	123	0·885	36·5	256	
10	123	0·880	36·3	247	
11	123	0·880	34·65	235	
12	123	0·880	33·7	229	
13	123	0·860	31·9	222	

10594

DIAGRAM TO TABLE V.



10595

Hours burning.

The arrows pointing downwards indicate the points at which each lamp burst.

The course of this curve, V, shows so decided a decrease in the effect in a few hours, as to render it probable that in 100 hours the effect would not have been 10596
greater than in II. A, III. A, and IV., if the lamps had held out so long.

If we collate the results obtained from the lamps with unprepared carbon filaments, we arrive at the conclusion that it is useless to sen l out these lamps with a higher initial effect than 170 normal candles per electric horse-power. Consequently, the basis of those

10597 calculations, which have the object of ascertaining the
most suitable values for their duration and effect in
proportion to the price, are perfectly deceptive.

From the curves B, it appears that the process ac-
cording to which Siemens and Halske's glow lamps are
prepared offers great advantages. Heretofore, it was
merely shown that these lamps at an equal tempera-
ture threw out a much more economical light than
lamps with unprepared filaments. But the present ex-
10598 periments have shown that these lamps possess, in a
high degree, the property of maintaining a high useful
effect during the time that it lasts, and of giving out a
uniform light.

It has been pointed out above that the Siemens and
Halske lamps at 100 volts, and of 16-candle power, are
prepared according to curve II. B, and not according
to curve II. A, though the mean effect is here some
what better. It may be appropriate to remark here
that lamps on various systems have made their appear-
10599 ance in commerce which are praised as having an un-
usually high useful effect. This is given as $2\frac{1}{2}$ and $2\frac{1}{4}$
volt-amperes per normal candle. The properties of
such lamps at 100 volts and 16 candles might, in the
best case, be shown by the curve III. B. If the ef-
fects of this curve, which have hitherto been expressed
in normal candles per horse-power, are calculated in
volt-amperes per normal candle, we find for the initial
effect 2.1 volt-amperes per normal candle, and for the
mean effect 2.8, whilst for the curve, II. B (normal
10600 curve for the Siemens and Halske lamps), the corres-
ponding values are 3.1 and 3.3.

Though there may be no doubt that the so-called $2\frac{1}{4}$ volt-ampere lamps may be exceedingly durable, it will be plain, from what has been already explained, that it is not advisable to go below 3 volt-amperes per normal candle.

This remark must, however, be restricted for the

present to the 16-candle lamps at 100 volts, and all 10601
lamps which have filaments of slender section. It has
been found that the above-mentioned method of pre-
paring filaments is still better adapted for thick car-
bons, and that the results thus obtained are still more
favorable. On this question I purpose making further
communications after the conclusions of the experi-
ments.

One more remark in conclusion. In the above ex-
position, prepared filaments (on Siemens and Halske's 10602
system) were simply contrasted with unprepared fila-
ments. The objection may be raised that the re-
searches on the latter are confined to a simple material
(bamboo) that the lamps used in this investigation
differ from the Siemens and Halske lamps in other de-
tails, and that possibly the last circumstance may
have affected the form of the curves.

It cannot, however, be assumed that there exist
carbonised fibres surpassing the bamboo-fibre in
strength and applicability for use in glow lamps. 10603

To the difficulty of testing the bamboo filaments in lamps constructed, in other respects, on the Siemens and Halske pattern, I have already referred. Still, the experiment shall be carried out, though I entertain no doubt but that the characteristic peculiarities of that fibre will re-appear in this case also. Elektrotech. Zeitschrift.

10605 **Defendant's Exhibit Franklin Institute Report.**

Report of a Special Committee appointed by the President of the Franklin Institute of the State of Pennsylvania on the Efficiency and Duration of Incandescent Electric Lamps. Published by the Franklin Institute at Philadelphia in 1885.

10606

FRANKLIN INSTITUTE OF THE STATE OF PENNSYLVANIA.
FOR THE PROMOTION OF MECHANIC ARTS.

To the Board of Managers of the Franklin Institute:

GENTLEMEN:—I herewith transmit the report of the Committee, consisting of J. B. Murdoch, Lieut. U. S.
10607 Navy; Louis Duncan, Ph.D., Ensign U. S. Navy; William D. Marks, Whitney Professor of Dynamic Engineering, University of Pennsylvania; George M. Ward, M. D., Photometric Expert of the Trustees of the Philadelphia Gas Works, appointed under authority of the resolution of the Board, adopted November 12, 1884, to conduct examinations and tests of the efficiency and life duration of incandescent lamps.

I believe that the examination has been more thorough and that the report is more complete than any-
10608 thing that has hitherto appeared on the subject; and the Institute is deeply indebted to the members of the Committee for their faithful, zealous and intelligent discharge of their protracted duties.

Very respectfully,
W. P. TATHAM,
President.

Philadelphia, July 8, 1885.

*　*　*　*　*

DURATION TEST OF INCANDESCENT LAMPS. 10609

The scheme for a duration of life test of incandescent lamps was organized during the Electrical Exhibition by the Executive Committee. It had been recognized that tests of incandescent lamps for the determination of the efficiency alone afforded no data for deciding upon their relative value, the lifetime of the lamp being an important factor in the question of economy. A test which should furnish information on
this point would be very valuable. Plans were early 10610
made for such a test, but as the time required was such that it could not be conducted by the Photometric Group of the Board of Examiners, it was placed in charge of a special committee, and invitations were extended to the principal incandescent light companies to enter their lamps. Before the necessary arrangements could be completed several of the members of the special committee were compelled by their engagements to leave Philadelphia.

The Board of Managers of the Franklin Institute 10611
thereupon placed the conduct of the tests in the hands of its president, who filled the vacancies existing in the committee and authorized preparations for conducting the test on a larger scale than was possible during the continuance of the Electrical Exhibition. Three rooms in the exhibition building were set apart for the test.

A code had been prepared, specifying how the test should be conducted. This code was signed in De-
cember by Mr. Weston and Mr. Upton, representing 10612
the interests of the United States and the Edison companies. The Brush-Swan and the Bernstein companies declined to enter their lamps. The Franklin Institute entered a lot of Woodhouse & Rawson lamps, obtained from the Van de Poele Company, and also two grades of the Stanley-Thompson lamp, made by the Union Switch and Signal Company of Pittsburg. The presi-

10613 dent of the Franklin Institute subsequently entered, for efficiency measurements and for such a test of duration as circumstances would permit, a lot of Weston lamps (paper carbon) furnished by Mr. Weston; a lot of Woodhouse & Rawson lamps, received from the Edison Lamp Company, and a lot of White lamps, from the Electrical Supply Company.

In order to secure satisfactory results, and prevent needless discussion, the following code was agreed
10614 upon for the conduct of the test:

* * * * *

The test began with the following lamps entered:

20 Weston . . . . $110\frac{1}{2}$ volts. Tamadine carbon
20 Edison . . . . 94–100 "
10 Woodhouse & Rawson, 55 "
10 Stanley-Thompson . . . . 96 "
10 " " . . . . 44 "

10615

* * * * *

The Edison lamps, Fig. 1, were similar in appearance to those generally used. The carbon was made from bamboo fibre. The lamps were mounted in the ordinary screw socket, which gave good contact with great facility of handling.

* * * * *

10616 MEASUREMENTS OF EFFICIENCY.

The general method of making the observations for efficiency has already been stated. The committee aimed to test each lamp at its normal potential as stated by the makers, and to place it in the test for duration at the same potential, that the relation between efficiency and life might be traced. A few lamps were tested at two or more potentials. The efficiency measurements were begun at the earliest 10617
moment when it was thought that the arrangements for the test were sufficiently advanced to secure good results.

* * * * *

EDISON LAMPS.

Although only twenty-three lamps were required to be measured for the duration test, a larger number 10618
were examined, and the efficiency results are appended. The first twenty of the lamps were tested for duration, and the curves in the diagram, Fig. 7 were calculated from them. But few peculiarities were observed in these lamps. One, through a peculiar distortion of the carbon gave an almost circular curve of horizontal distribution, but the curves of the others were essentially the same as in the diagram. Owing to the causes already mentioned, the potential of the lamps is generally $\frac{7}{10}$ths of a volt higher than the normal. The 10619
tables give all the data of the tests. The lamps were taken at random from four hundred furnished by the company.

* * * * *

In reviewing the results of the test, the committee note discrepancies in the candle-power. From the continuous nature of the test, no repetition of the work was possible, and the discrepancies referred to were 10620
shown to be such, only by observations on subsequent days. Under these circumstances no verification could be made. In order to facilitate comparison they feel justified in rejecting the observations of April 25, 27, 28, 29, and May 15 and 25, as not in accord with the others of the series.

After the test, the discoloration of each lamp was estimated by comparison with six lamps taken as stan-

10621 dards. Number one showed the least discoloration, and number six the greatest, the latter having its carbon destroyed by too high a potential.

The committee present the following summary of the results (Tables XI–XVII): Whenever the candle power was observed at too high or too low potential, the former is reduced to what it would have been at normal potential by such an allowance as seems proper, the general rules being given for each lot of lamps. These
10622 values are derived from the data given in the tables of efficiency and duration, and are believed to be substantially correct.

EDISON. (TABLE XI.)

In allowing for the potential being other than normal, one volt is assumed to cause a difference of mean horizontal intensity of one candle. The whole lot of lamps behaved with great uniformity, there being in all a gradual increase of resistance throughout the
10623 test.

* * * * *

The daily records of the lamps are appended (page 56, *et seq*). The calculations have been carefully revised. The first line of each lamp record contains the results of the preliminary efficiency measurements. The entries of candles under date of April 11, are the results of photometer readings at the beginning of the test. The resistances had all been adjusted previously
10624 but it was thought desirable to check with the photometer that no lamp might be forced by an accidental high potential. The astericks against the dates show that the observations made on those days are rejected as not in accordance with others of the series. The time is recorded in hours and minutes, to the nearest quarter of an hour.

10625

Lamps.	Hours of Test.	Life of Lamp.	Candles, efficiency measurements. Spherical.	Candles, efficiency measurements. Horizontal.	CANDLES. Spherical.	CANDLES. Horizontal.	CANDLES.	Discoloration.	
1	1,066	Survived.	15.3	18.8	9.3	11.4	After 1,006 hrs.	3	
2	1,055	"	13.6	16.7	9.9	12.2	" " "	2	
3	"	"	14.2	17.2	9.7	11.7	" " "	2	
4	"	"	15.0	18.6	9.6	11.9	" " "	2	
5	"	"	15.7	19.5	10.5	13.0	" " "	2½	
6	"	"	14.0	17.1	10.3	12.7	" " "	2½	10626
7	"	"	14.0	17.6	9.3	11.7	" " "	2½	
8	"	"	16.0	19.4	10.1	12.2	" " "	3	
9	"	"	14.4	17.7	9.7	11.9	" " "	2½	
10	"	"	14.0	17.7	9.8	12.4	" " "	2	
11	"	"	16.1	20.3	9.8	12.4	" " "	3	
12	"	"	13.1	16.7	10.3	13.1	" " "	2	
13	"	"	14.9	18.3	10.1	12.4	" " "	2½	
14	"	"	15.1	19.0	9.3	11.7	" " "	3	
15	"	295	15.1	19.0	12.4	15.6	" 260 "	2	
16	"	Survived.	15.5	19.6	9.3	11.7	" 1,006 "	2½	
17	"	"	16.0	20.3	8.9	11.3	" " "	3	
18	"	"	15.0	18.5	9.0	11.1	" " "	2½	10627
19	"	"	15.4	18.8	9.5	11.6	" " "	2½	
20	"	"	15.2	18.9	9.0	11.2	" " "	2	

Deft's Exhibit:— Pope's Diagram of the Franklin Institute Test of Incandescent Lamps.

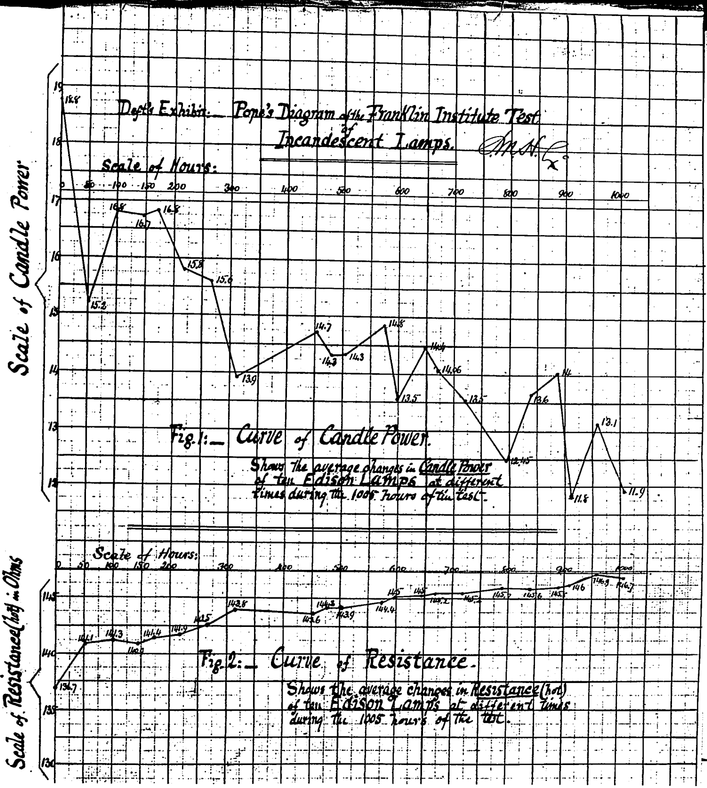


Fig. 1:— Curve of Candle Power.

Shows the average changes in Candle Power of ten Edison Lamps at different times during the 1005 hours of the test.

Fig. 2:— Curve of Resistance.

Shows the average changes in Resistance (hot) of ten Edison Lamps at different times during the 1005 hours of the test.

Edison Lamps.

Edison Lamp, No. 1, 99 Volts.

(Reduction Factor, ·96. Resistance Cold, 260.)

Date	Volts.	Amperes.	Watts.	Candles. Observed.	Candles. Spherical.	Watts per Spher. Cand.	Mean Horizontal Candles.	Resistance Hot.	Hours.	Total Hours.
1885. April.	96·9	·690	68·24	15·90	15·31	4·45	18·81	143·3	1·45	1·45
11				15·5	14·9		18·3		3·45	5·30
12									24·00	29·30
13	97·1	·664	64·48	12·3	11·8		14·5	146·2	24·00	53·30
14	99·0								24·00	77·30
15	98·0	·663	64·97	14·1	13·5		16·6	147·8	24·00	101·30
16	98·9								24·00	125·30
17	99·0	·675	66·83	13·7	13·2		16·2	146·7	24·00	149·30
18	100·2	·679	68·04	15·1	14·5		17·8	147·6	24·00	173·30
19	99·5								24·00	197·30
20	98·1	·655	64·26	12·4	11·9		14·6	149·5	20·45	218·15
21	99·7								24·00	242·15
22	98·6	·662	65·27	13·1	12·6		15·5	148·9	24·00	266·15
23	99·0								24·00	290·15
24	99·0	·660	65·34	12·3	11·8		14·5	150·0	24·00	314·15
*25	99·4	·665	66·10	10·4	10·0		12·3	149·5	24·00	338·15
26	99·0								21·00	359·15
*27	98·8	·659	65·11	10·0	9·6		11·8	149·9	24·00	383·15
*28	99·0	·657	65·04	10·0	9·6		11·8	150·7	24·00	407·15
*29	99·3	·658	65·34	9·6	9·2		11·3	150·9	24·00	431·15
30	98·7	·655	64·64	11·9	11·4		14·0	150·7	24·00	455·15
May										
1	99·1	·655	64·91	11·9	11·4		14·0	151·3	24·00	479·15
2	98·9	·656	64·87	11·7	11·2		13·8	150·8	24·00	503·15
3	98·9								24·00	527·15
4	99·0								24·00	551·15
5	99·2	·655	64·97	12·0	11·5		14·1	151·5	24·00	575·15
6	98·9	·647	63·98	10·7	10·3		12·7	152·9	23·30	598·45
7	98·8								24·00	622·45
8	98·8	·649	64·12	11·3	10·8		13·3	152·2	24·00	646·45
9	99·0	·646	63·95	11·6	11·1		13·3	153·3	24·00	670·45
10	98·9								24·00	694·45
11	98·9	·648	64·08	10·9	10·5		12·9	152·6	24·00	718·45
12	98·8								24·00	742·45
13	99·2								23·30	766·15
14	99·2	·646	64·08	10·5	10·1		12·4	153·6	24·00	790·15
15	99·0								24·00	814·15
16	98·6	·645	63·50	11·4	10·9		13·4	152·9	24·00	838·15
17	99·1								24·00	862·15
18	98·9	·642	63·49	11·3	10·8		13·8	151·1	24·00	886·15
19	98·8	·641	63·33	9·3	8·9		10·9	154·1	24·00	910·15
20	99·0								24·00	934·15
21	99·0	·639	63·26	10·5	10·1		12·4	154·9	24·00	958·15
22	99·1								24·00	982·15
23	98·7	·637	62·87	9·5	9·1		11·2	154·9	24·00	1,006·15
24	98·9								24·00	1,030·15
*25	98·8	·639	63·13	7·3	7·0		8·6	154·6	24·00	1,054·15
26									11·00	1,065·45
28										

Resistance Cold, 281. Discoloration, 3.

Edison Lamp, No. 2, 98 Volts.

(Reduction Factor, 1·03. Resistance Cold, 252.)

Date.	Volts.	Amperes.	Watts.	Candles. Observed.	Candles. Spherical.	Watts per Spher. Cand.	Candles, Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
1885. April.	98·9	·703	69·44	13·95	14·38	4·83	17·62	140·7	1·00	1·00
11				16·0	16·5		20·3		3·45	4·45
12									24·00	28·45
13	98·3	·617	62·31	10·1	10·4		12·8	148·8	24·00	52·45
14	98·3								24·00	76·45
15	97·2	·661	64·25	12·2	12·6		15·5	147·1	24·00	100·45
16	98·8								24·00	124·45
17	98·6	·668	65·88	12·3	12·7		15·6	147·6	24·00	148·45
18	97·8	·666	65·13	11·9	12·3		15·1	146·8	24·00	172·45
19	98·6								24·00	196·45
20	97·6	·660	64·41	11·3	11·6		14·3	147·9	20·45	217·30
21	98·8								24·00	241·30
22	97·7	·660	64·48	11·1	11·4		14·0	148·0	24·00	265·30
23	98·4								24·00	289·30
24	98·2	·654	64·22	10·7	11·0		13·5	150·2	24·00	313·30
*25	98·4	·664	65·34	10·0	10·3		12·7	148·2	24·00	337·30
26	98·1								21·00	358·30
*27	97·9	·656	64·22	9·2	9·5		11·7	149·2	24·00	382·30
*28	98·0	·657	64·38	7·9	8·1		10·0	149·2	24·00	406·30
*29	98·2	·658	64·61	8·9	9·2		11·3	149·2	24·00	430·30
30	97·8	·653	63·66	10·6	10·9		13·4	149·8	24·00	454·30
May.										
1	98·1	·656	64·35	10·7	11·0		13·5	149·5	24·00	478·30
2	97·8	·656	64·15	11·0	11·3		13·9	149·1	24·00	502·30
3	98·0								24·00	526·30
4	97·9								24·00	550·30
5	98·0	·657	64·38	11·3	11·6		14·3	149·2	24·00	574·30
6	97·8	·651	63·66	10·1	10·4		12·8	150·2	23·30	598·00
7	97·8								24·00	622·00
8	97·9	·655	64·12	11·3	11·6		14·3	149·5	24·00	646·00
9	98·0	·657	64·38	11·4	11·7		14·4	149·2	24·00	670·00
10	97·7								24·00	694·00
11	97·9	·653	63·92	10·6	10·9		13·4	149·9	24·00	718·00
12	98·0								24·00	742·00
13	98·5								23·00	765·00
14	98·0	·655	64·19	10·0	10·3		12·7	149·6	24·30	789·30
15	98·0								24·00	813·30
16	97·7	·650	63·50	10·8	11·1		13·7	150·3	24·00	837·30
17	98·0								24·00	861·30
18	97·7	·649	63·40	11·0	11·3		13·9	150·5	24·00	885·30
19	97·7	·648	63·31	8·7	9·0		11·1	150·4	24·00	909·30
20	97·9								24·00	933·30
21	98·0	·648	63·50	10·3	10·6		13·0	151·2	24·00	957·30
22	97·8								24·00	981·30
23	97·6	·646	63·04	9·3	9·6		11·8	151·1	24·00	1,005·30
24	97·9								24·00	1,029·30
*25	97·7	·646	63·11	7·3	7·5		9·2	151·2	24·00	1,053·30
26									11·30	1,065·00
28										

Resistance Cold, 267. Discoloration, 2.

Edison Lamp, No. 3, 95 Volts.

(Reduction Factor, 0·91. Resistance Cold, 241.)

Date.	Volts.	Amperes.	Watts.	Candles.		Watts per Spher. Cand.	Candles. Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
				Observed.	Spherical.					
1885. April.	95·8	·711	68·12	16·32	14·87	4·58	18·03	134·7	0·30	0·30
11				13·3	12·1		14·6		3·45	4·15
12									24·00	28·15
13	93·5	·650	60·77	10·4	9·5		11·5	143·8	24·00	52·15
14	95·4								24·00	76·15
15	94·2	·661	62·55	12·1	11·0		13·3	141·9	24·00	100·15
16	97·2								24·00	124·15
17	95·7	·675	64·00	12·1	11·0		13·3	141·5	24·00	148·15
18	95·2	·668	63·50	12·0	10·9		13·2	142·5	24·00	172·15
19	95·9								24·00	196·15
20	94·5	·667	64·03	12·2	11·1		13·4	141·7	20·45	217·00
21	96·1								24·00	241·00
22	95·2	·661	62·02	11·6	10·6		12·8	144·0	24·00	265·00
23	95·2								24·00	289·00
24	95·1	·660	63·02	11·4	10·4		12·6	142·2	24·00	313·00
*25	95·2	·661	62·02	9·8	8·9		10·8	144·0	24·00	337·00
26	95·3								21·00	358·00
*27	95·0	·658	62·51	9·4	8·6		10·4	144·4	24·00	382·00
*28	94·8	·674	63·76	10·4	9·5		11·5	140·4	24·00	406·00
*29	94·9	·675	64·05	10·5	9·6		11·6	140·6	24·00	430·00
30	94·4	·671	63·31	12·4	11·3		13·7	140·7	21·00	451·00
May.										
1	94·7	·671	63·54	12·9	11·7		14·2	141·1		
2	94·9	·670	64·43	12·9	11·7		14·2	139·8	24·00	478·00
3	94·9								24·00	502·00
4	95·0								24·00	526·00
5	95·0	·674	64·03	13·2	12·0		14·5	140·9	24·00	550·00
6	94·8	·673	63·80	11·7	10·6		12·8	140·9	24·00	574·00
7	94·8								23·30	597·30
8	94·8	·669	63·12	13·2	12·0		14·5	141·7	24·00	621·30
9	95·0	·670	63·63	12·5	11·4		13·8	141·8	24·00	645·30
10	94·8								24·00	669·30
11	95·0	·670	63·64	12·0	10·9		13·2	141·8	24·00	693·30
12	94·9								24·00	717·30
13	95·0								24·00	741·30
14	95·0	·670	63·64	11·3	10·3		12·5	141·3	23·30	765·00
15	95·2								24·00	789·00
16	94·8	·667	63·23	12·0	10·9		13·2	142·1	24·00	813·00
17	95·2								24·00	837·00
18	95·0	·665	64·17	12·6	11·5		13·9	142·9	24·00	861·00
19	94·8	·661	62·94	10·5	9·6		11·6	142·8	24·00	885·00
20	94·9								24·00	909·00
21	94·9	·661	63·01	11·6	10·6		12·8	142·9	24·00	933·00
22	95·2								24·00	957·00
23	94·8	·661	62·60	10·5	9·5		11·6	143·4	24·00	981·00
24	94·9								24·00	1,005·00
*25	94·8	·662	62·75	8·3	7·6		9·2	143·2	24·00	1,029·00
26									24·00	1,053·00
28									11·30	1,064·30

Resistance Cold, 257. Discoloration, 2.

Edison Lamp, No. 4, 95 Volts.

(Reduction Factor, 0·93. Resistance Cold, 244.)

Date.	Volts.	Amperes.	Watts.	Candles.		Watts per Spher. Cand.	Candles. Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
				Observed.	Spherical.					
1885. April.	95·8	·716	68·79	16·90	15·72	4·37	19·44	133·4	0·30	0·30
11				17·4	16·2		20·1		3·45	4·15
12									24·00	28·15
13	93·3	·676	63·07	13·6	12·7		15·7	138·0	24·00	52·15
14	95·2								24·00	76·15
15	93·7	·682	64·91	15·2	14·1		17·5	137·4	24·00	100·15
16	97·2								24·00	124·15
17	95·5	·692	66·09	14·5	13·5		16·7	138·0	24·00	148·15
18	95·3	·690	65·96	14·5	13·5		16·7	138·6	24·00	172·15
19	95·8								24·00	196·15
20	96·0	·693	66·53	15·6	14·5		18·0	138·5	20·45	217·00
21	96·2								24·00	241·00
22	95·1	·678	64·47	13·7	12·7		15·7	140·3	24·00	265·00
23	95·3								24·00	289·00
24	95·2	·677	64·45	12·8	11·9		14·8	140·6	24·00	313·00
*25	95·2	·673	64·07	11·7	10·9		13·5	141·5	24·00	337·00
26	95·2								21·00	358·00
*27	94·8	·671	63·61	11·2	10·4		12·9	141·3	24·00	382·00
*28	95·0	·670	64·65	10·1	9·4		11·7	141·8	24·00	406·00
*29	95·2	·672	63·07	10·2	9·5		11·8	141·7	24·00	430·00
30	95·3	·674	64·23	13·1	12·2		15·1	141·4	24·00	454·00
May.										
1	95·2	·673	64·07	12·6	11·7		14·5	141·5		
2	95·0	·670	63·61	12·4	11·5		14·3	141·8	24·00	478·00
3	95·1								24·00	502·00
4	95·0								24·00	526·00
5	95·1	·668	63·52	13·2	12·3		15·3	142·4	24·00	550·00
6	95·2	·668	63·59	11·7	10·9		13·5	142·5	24·00	574·00
7	94·8								23·30	597·30
8	95·0	·665	63·17	12·5	11·6		14·4	142·9	24·00	621·30
9	95·2	·665	63·31	12·5	11·6		14·4	143·2	24·00	645·30
10	94·8								24·00	669·30
11	95·0	·664	63·08	11·7	10·9		13·5	143·1	24·00	693·30
12	94·9								24·00	717·30
13	95·5								24·00	741·30
14	95·1	·659	62·67	10·7	10·0		12·4	141·3	23·30	765·00
15	95·3								24·00	789·00
16	94·9	·660	62·63	11·6	10·8		13·4	143·3	24·00	813·00
17	95·3								24·00	837·00
18	95·2	·659	62·73	11·3	10·5		13·0	144·5	24·00	861·00
19	94·8	·658	62·37	9·9	9·2		11·4	144·1	24·00	885·00
20	95·0								24·00	909·00
21	95·2	·658	62·64	11·2	10·4		12·9	144·7	24·00	933·00
22	95·5								24·00	957·00
23	94·8	·653	61·90	10·2	9·5		11·8	145·2	24·00	981·00
24	94·8								24·00	1,005·00
*25	95·0	·656	62·31	8·1	7·5		9·3	144·8	24·00	1,029·00
26									24·00	1,053·00
28									11·30	1,064·30

Resistance Cold, 261. Discoloration, 2½.

Edison Lamp, No. 5, 97 Volts.

(Reduction Factor, 0·95. Resistance Cold, 244.)

Date.	Volts.	Amperes.	Watts.	Candles. Observed.	Candles. Spherical.	Watts per Spher. Cand.	Candles. Mean Horizontal.	Resistance Hot.	Hours.	Total hours.
1885. April.	97·8	·718	70·21	17·32	16·41	4·27	20·23	136·2	0·30	0·30
11				18·4	17·5		21·7		3·45	4·15
12									24·00	28·15
13	95·2	·685	65·22	14·4	13·7		17·0	139·0	24·00	52·15
14	97·0								24·00	76·15
15	95·6	·683	65·20	15·9	15·1		18·7	140·2	24·00	100·15
16	96·7								24·00	124·15
17	97·2	·690	67·91	16·0	16·0		19·8	139·1	24·00	148·15
18	96·5	·691	66·60	15·3	14·5		18·0	139·7	24·00	172·15
19	97·3								24·00	196·15
20	96·5	·691	68·07	15·1	14·3		17·7	142·5	20·45	217·00
21	96·0								24·00	241·00
22	96·5	·687	66·30	15·0	14·3		17·7	140·5	24·00	265·00
23	97·7								24·00	289·00
24	97·2	·669	65·03	12·3	11·7		14·5	145·3	24·00	313·00
*25	97·4	·670	65·25	11·3	10·7		13·3	145·4	24·00	337·00
26	97·0								21·00	358·00
*27	96·6	·684	66·07	11·9	11·3		14·0	141·2	24·00	382·00
*28	97·2	·681	61·54	10·1	9·6		11·9	146·4	24·00	406·00
*29	97·8	·670	65·19	10·2	9·7		12·0	145·2	24·00	430·00
30	97·1	·675	65·51	13·3	12·6		15·6	143·9	24·00	454·00
May.										
1	97·4	·681	64·38	11·5	10·9		13·5	147·4	24·00	478·00
2	97·2	·681	64·54	11·4	10·8		13·4	146·4	24·00	502·00
3	97·2								24·00	526·00
4	97·1								24·00	550·00
5	97·3	·662	64·41	12·6	12·0		14·9	147·0	24·00	574·00
6	97·2	·662	64·31	11·5	10·9		13·5	146·8	23·30	597·30
7	97·0								24·00	621·30
8	97·3	·660	64·21	11·9	11·3		14·0	147·4	24·00	645·30
9	97·5	·658	64·16	11·4	10·8		13·4	148·2	24·00	669·30
10	97·2								24·00	693·30
11	97·1	·658	63·80	11·1	10·5		13·0	147·6	24·00	717·30
12	97·4								24·00	741·30
13	97·1								23·30	765·00
14	96·9	·655	63·46	10·0	9·5		11·8	147·9	24·00	789·00
15	97·0								24·00	813·00
16	96·7	·655	63·33	11·2	10·6		13·1	147·6	24·00	837·00
17	96·8								24·00	861·00
18	96·3	·670	64·52	13·5	12·8		15·9	143·7	24·00	885·00
19	96·9	·665	64·43	10·6	10·1		12·5	145·7	24·00	909·00
20	97·0								24·00	933·00
21	97·4	·658	64·09	11·5	10·9		13·5	148·0	24·00	957·00
22	97·5								24·00	981·00
23	96·7	·665	64·30	10·8	10·3		12·8	145·5	24·00	1,005·00
24	97·0								24·00	1,029·00
*25	97·1	·653	63·89	8·1	7·7		9·5	147·6	24·00	1,053·00
26									11·30	1,064·30
28										

Resistance Cold, 260. Discoloration, 2¼.

Edison Lamp, No. 6, 99 Volts.

(Reduction Factor, 0·91. Resistance Cold, 264.)

Date.	Volts.	Amperes.	Watts.	Candles. Observed.	Candles. Spherical.	Watts per Spher. Candles.	Candles. Mean Horizontal.	Resistance Hot.	Hours	Total Hours.
1885, April.	99·9	·692	69·13	16·07	14·67	4·71	17·98	144·4	0·30	0·30
11				18·6	16·9		20·8		3·45	4·15
12									24·00	28·15
13	97·8	·669	65·42	14·9	13·5		16·6	146·2	24·00	52·15
14	99·0								24·00	76·15
15	97·7	·659	64·38	15·8	14·4		17·7	148·3	24·00	100·15
16	100·8								24·00	124·15
17	99·6	·674	67·13	16·0	14·6		18·0	147·8	24·00	148·15
18	99·1	·670	66·40	16·2	14·7		18·1	147·9	24·00	172·15
19	99·2								24·00	196·15
20	99·8	·677	67·56	15·4	14·0		17·2	147·4	20·45	217·00
21	99·6								24·00	241·00
22	98·9	·664	65·66	15·4	14·0		17·2	148·9	24·00	265·00
23	99·1								24·00	289·00
24	99·1	·661	65·50	13·1	11·9		14·6	149·9	24·00	313·00
*25	99·2	·660	65·47	13·0	11·8		15·5	150·3	24·00	337·00
26	99·0								21·00	358·00
*27	99·1	·660	65·40	12·0	10·9		13·4	150·2	24·00	382·00
*28	99·0	·659	65·24	11·1	10·1		12·4	150·2	24·00	406·00
*29	99·0	·659	65·24	11·2	10·2		12·5	150·2	24·00	430·00
30	99·1	·658	65·20	13·8	12·6		15·5	150·6	24·00	454·00
May.										
1	99·2	·658	65·27	14·0	12·7		15·6	150·8	24·00	478·00
2	98·9	·655	64·78	13·2	12·0		14·8	151·0	24·00	502·00
3	99·0								24·00	526·00
4	98·9								24·00	550·00
5	98·9	·652	64·48	14·0	12·7		15·6	151·7	24·00	574·00
6	99·2	·650	64·47	12·8	11·6		14·3	152·6	23·30	597·30
7	98·8								24·00	621·30
8	98·9	·650	64·28	13·6	12·4		15·3	152·2	24·00	645·30
9	99·1	·650	64·41	13·3	12·1		14·9	152·5	24·00	669·30
10	98·9								24·00	693·30
11	98·9	·650	64·28	12·7	11·6		14·3	152·2	24·00	717·30
12	99·1								24·00	741·30
13	99·1								23·30	765·00
14	99·0	·647	64·05	11·6	10·6		13·0	153·0	24·00	789·00
15	99·0								24·00	813·00
16	98·8	·645	63·72	12·7	11·6		14·3	153·2	24·00	837·00
17	98·1								24·00	861·00
18	98·9	·646	63·89	13·4	12·2		15·0	153·1	24·00	885·00
19	99·0	·645	63·85	11·4	10·4		12·8	153·5	24·00	909·00
20	98·1								24·00	933·00
21	98·8	·642	63·43	12·6	11·5		14·1	153·9	24·00	957·00
22	99·0								24·00	981·00
23	98·8	·641	63·33	11·1	10·1		12·4	154·1	24·00	1,005·00
24	99·0								24·00	1,029·00
*25	99·1	·642	63·62	8·5	7·7		9·5	154·4	24·00	1,053·00
26									11·30	1,064·30
28										

Resistance Cold, 279. Discoloration, 2¼.

Edison Lamp, No. 7, 95 Volts.

(Reduction Factor, 0·88. Resistance Cold, 235.)

Date.	Volts.	Amperes.	Watts.	Candles. Observed.	Candles. Spherical.	Watts per Spher. Cand.	Candles, Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
1885. April.	95·8	·736	70·31	16·50	14·57	4·82	18·43	130·2	0·45	0·45
11				16·8	14·8		18·6		3·45	4·30
12									24·00	28·30
13	93·8	·699	65·57	12·9	11·4		14·4	131·2	24·00	52·30
14	95·1								24·00	76·30
15	94·2	·692	65·19	14·4	12·7		16·0	136·1	24·00	100·30
16	96·7								24·00	124·30
17	95·3	·709	67·92	14·2	12·5		15·8	135·1	24·00	148·30
18	95·6	·703	67·21	15·1	13·8		16·8	136·0	24·00	172·30
19	95·4								24·00	196·30
20	94·5	·699	66·05	13·7	12·1		15·2	135·2	20·45	217·15
21	95·2								24·00	241·15
22	95·0	·695	66·03	13·7	12·1		15·2	136·7	24·00	265·15
23	95·1								24·00	289·15
24	94·9	·698	66·24	11·6	10·2		12·9	136·0	24·00	313·15
•25	95·2	·700	66·64	12·2	10·7		13·5	136·0	24·00	337·15
26	95·1								21·00	358·15
•27	95·1	·695	66·09	11·4	10·0		12·6	136·8	24·00	382·15
•28	95·0	·685	65·07	10·5	9·2		11·6	138·7	24·00	406·15
•29	95·1	·691	65·71	10·2	9·0		11·3	137·6	24·00	430·15
30	95·2	·693	65·97	13·0	11·4		14·4	137·4	24·00	454·15
May.										
1	95·0	·691	65·64	12·1	10·6		13·4	137·5	24·00	478·15
2	95·0	·690	65·55	12·9	11·4		14·4	137·7	24·00	502·15
3	94·9								24·00	526·15
4	95·1								24·00	550·15
5	94·9	·688	65·29	13·4	11·8		14·9	137·9	24·00	574·15
6	95·1	·688	65·12	12·1	10·6		13·4	138·2	23·30	597·45
7	94·9								24·00	621·45
8	95·1	·687	65·33	12·8	11·3		14·2	138·4	24·00	645·45
9	95·1	·686	65·21	12·1	10·6		13·4	138·6	24·00	669·45
10	94·9								24·00	693·45
11	95·0	·686	65·16	12·0	10·6		13·4	138·5	24·00	717·45
12	94·9								24·00	741·45
13	95·1								23·30	765·15
14	95·1	·684	65·04	11·1	9·8		12·3	139·0	24·00	789·15
15	95·0								24·00	813·15
16	94·8	·683	64·74	11·7	10·3		13·0	138·8	24·00	837·15
17	95·3								24·00	861·15
18	94·9	·681	64·82	12·2	10·7		13·5	139·4	24·00	885·15
19	95·0	·682	64·78	10·5	9·2		11·6	139·8	24·00	909·15
20	94·9								24·00	933·15
21	95·0	·678	64·41	11·5	10·1		12·7	140·1	24·00	957·15
22	94·9								24·00	981·15
23	94·9	·676	64·15	10·4	9·2		11·6	140·3	24·00	1,005·15
24	95·0								24·00	1,029·15
•25	95·1	·678	64·47	8·2	7·2		9·1	140·3	24·00	1,053·15
26									11·30	1,064·45
28										

Resistance Cold, 219. Discoloration, 2½.

Edison Lamp, No. 8, 97 Volts.

(Reduction Factor, 0·84. Resistance Cold, 239.)

Date.	Volts.	Amperes.	Watts.	Candles. Observed.	Candles. Spherical.	Watts per Spher. Cand.	Candles, Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
1885. April.	97·9	·729	71·37	19·97	16·81	4·24	20·32	134·3	0·45	0·45
11				20·0	16·8		20·3		3·45	4·30
12									24·00	28·30
13	95·9	·696	68·75	17·0	14·3		17·3	137·8	24·00	52·30
14	96·9								24·00	76·30
15	95·0	·699	67·03	18·3	15·4		18·6	137·2	24·00	100·30
16	98·4								24·00	124·30
17	97·2	·712	69·20	18·7	15·7		19·0	136·5	24·00	148·30
18	97·2	·703	68·33	17·7	14·9		18·0	138·3	24·00	172·30
19	97·5								24·00	196·30
20	96·5	·699	67·45	17·1	14·4		17·1	138·1	20·45	217·15
21	97·0								24·00	241·15
22	96·8	·697	67·47	16·2	13·6		16·5	138·9	24·00	265·15
23	97·2								24·00	289·15
24	96·8	·694	67·18	14·1	11·8		14·3	139·5	24·00	313·15
•25	97·0	·695	67·41	14·1	11·8		14·3	139·6	24·00	337·15
26	97·1								21·00	358·15
•27	97·1	·693	67·29	13·2	11·1		13·4	140·1	24·00	382·15
•28	97·1	·692	67·19	12·1	10·2		12·3	140·3	24·00	406·15
•29	97·2	·691	67·16	11·9	10·0		12·1	140·7	24·00	430·15
30	97·0	·692	67·12	15·1	12·7		15·4	140·2	24·00	454·15
May.										
1	97·1	·690	67·00	14·3	12·0		14·5	140·7	24·00	478·15
2	96·8	·689	66·69	14·9	12·5		15·1	140·5	24·00	502·15
3	97·0								24·00	526·15
4	97·1								24·00	550·15
5	97·0	·686	66·51	15·1	12·7		15·4	141·4	24·00	574·15
6	97·0	·684	66·34	13·5	11·3		13·7	141·8	23·30	597·45
7	96·8								24·00	621·45
8	97·0	·682	66·15	14·6	12·3		14·9	142·2	24·00	645·45
9	97·1	·682	66·22	14·3	12·0		14·5	142·4	24·00	669·45
10	96·9								24·00	693·45
11	96·9	·682	66·08	13·5	11·3		13·7	142·1	24·00	717·45
12	97·0								24·00	741·45
13	97·2								23·30	765·15
14	97·1	·678	65·83	12·4	10·4		12·6	143·2	24·00	789·15
15	97·1								24·00	813·15
16	97·0	·680	65·96	13·9	11·7		14·2	142·6	24·00	837·15
17	97·2								24·00	861·15
18	97·2	·676	65·90	13·7	11·5		13·9	143·4	24·00	885·15
19	97·0	·677	65·66	11·7	9·8		11·9	143·3	24·00	909·15
20	97·1								24·00	933·15
21	97·0	·674	65·37	12·8	10·8		13·1	143·9	24·00	957·15
22	97·0								24·00	981·15
23	96·8	·671	64·95	11·8	9·9		12·0	144·3	24·00	1,005·15
24	96·9								24·00	1,029·15
•25	97·0	·674	65·37	9·4	7·9		9·6	143·9	24·00	1,053·15
26									11·30	1,064·45
28										

Resistance Cold, 250. Discoloration, 3.

Edison Lamp, No. 9, 95 Volts.

(Reduction Factor, 1·00. Resistance Cold, 240.)

Date.	Volts.	Amperes.	Watts.	Candles.		Watts per Spher. Cand.	Candles. Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
				Observed.	Spherical.					
1885. April.	95·8	·718	68·79	15·1	15·11	4·53	18·51	133·4	0·30	0·30
11	....	....	....	15·5	15·5	....	19·1	....	3. 45	4·15
12	....	....	....	....	....	....	....	....	24·00	28·15
13	94·2	·686	64·62	13·2	13·2	....	16·2	137·3	24·00	52·15
14	95·0	....	....	....	....	....	....	....	24·00	76·15
15	94·3	·691	65·16	1·43	14·3	....	17·6	136·5	24·00	100·15
16	96·7	....	....	....	....	....	....	....	24·00	124·15
17	94·7	·696	65·91	13·8	13·8	....	17·0	136·1	24·00	148·15
18	94·6	·692	65·46	14·3	14·3	....	17·6	136·7	24·00	172·15
19	95·9	....	....	....	....	....	....	....	24·00	196·15
20	94·0	·686	64·48	12·1	12·1	....	14·9	137·0	20·45	217·00
21	95·3	....	....	....	....	....	....	....	24·00	241·00
22	94·8	·688	65·22	12·9	12·9	....	15·9	137·8	24·00	265·00
23	95·3	....	....	....	....	....	....	....	24·00	289·00
24	95·1	·690	65·62	11·1	11·1	....	13·7	137·8	24·00	313·00
*25	95·2	·687	65·40	11·0	11·0	....	13·5	138·6	24·00	337·00
26	95·1	....	....	....	....	....	....	....	21·00	358·00
*27	94·9	·683	64·72	10·4.	10·4	....	13·8	139·2	24·00	382·00
*28	95·1	·681	64·76	9·7	9·7	....	11·9	139·6	24·00	406·00
*29	95·2	·684	65·18	9·5	9·5	....	11·7	139·3	24·00	430·00
30	95·1	·683	64·95	12·6	12·6	....	15·5	139·2	21·00	451·00
May.										
1	95·3	·682	64·90	12·2	12·2	....	15·0	139·7	24·00	478·00
2	95·1	·680	64·66	11·6	11·6	....	14·8	139·9	24·00	502·00
3	95·1	....	....	....	....	....	....	....	24·00	526·00
4	95·1	....	....	....	....	....	....	....	24·00	550·00
5	95·1	·678	64·47	11·8	11·8	....	14·5	140·3	24·00	574·00
6	94·9	·674	63·96	11·4	11·4	....	14·0	140·8	23·30	597·30
7	95·0	....	....	....	....	....	....	....	24·00	621·30
8	95·3	·678	64·61	11·7	11·7	....	14·4	140·6	24·00	645·30
9	95·2	·676	64·36	11·7	11·7	....	14·4	140·8	24·00	669·30
10	95·1	....	....	....	....	....	....	....	24·00	693·30
11	95·0	·674	64·08	11·0	11·0	....	13·5	140·9	24·00	717·30
12	94·9	....	....	....	....	....	....	....	24·00	741·30
13	95·3	....	....	....	....	....	....	....	23·30	765·00
14	95·1	·674	64·09	9·8	9·8	....	12·1	141·1	24·00	789·00
15	95·4	....	....	....	....	....	....	....	24·00	813·00
16	95·2	·675	64·26	11·0	11·0	....	13,5	141·0	24·00	837·00
17	95·3	....	....	....	....	....	....	....	24·00	861·00
18	95·0	·668	63·46	11·0	11·0	....	13·5	142·2	24·00	885·00
19	95·0	·668	63·46	9·5	9·5	....	11·7	142·2	24·00	909·00
20	94.9	....	....	....	....	....	....	....	24·00	933·00
21	95·0	·666	63·26	10·7	10·7	....	13·2	142·6	24·00	957·00
22	95·3	....	....	....	....	....	....	....	24·00	981·00
23	94·8	·663	62·85	9·6	9·6	....	11·8	143·0	24·00	1,005·00
24	95·0	....	....	....	....	....	....	....	24·00	1,029·00
*25	95·1	·666	63·33	7·5	7·5	....	9·2	142·9	24·00	1,053·00
26	....	....	....	....	....	....	....	....	11·30	1,064·30
27	....	....	....	....	....	....	....	....	....	....

Resistance Cold, 257. Discoloration, 2½.

Edison Lamp, No. 10, 97 Volts.

(Reduction Factor, 0·98. Resistance Cold, 246.)

Date.	Volts.	Amperes.	Watts.	Candles.		Watts per Spher. Cand.	Candles Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
				Observed.	Spherical.					
1885. April.	97·8	·714	69·83	14·92	14·68	4·79	18·54	137·0	0·30	0·30
11	....	....	....	16·8	16·5	....	21·0	....	3·45	4·15
12	....	....	....	....	....	....	....	....	24·00	28·15
13	96·2	·690	66·28	12·8	12·5	....	15·0	139·6	24·00	52·15
14	97·0	....	....	....	....	....	....	....	24·00	76·15
15	96·3	·687	66·16	13·5	13·2	....	16·8	140·2	24·00	100·15
16	98·2	....	....	....	....	....	....	....	24·00	124·15
17	96·5	·688	66·40	12·8	12·6	....	16·0	140·3	24·00	148·15
18	95·7	·685	65·56	13·4	13·1	....	16·6	139·7	24·00	172·15
19	97·8	....	....	....	....	....	....	....	24·00	196·15
20	96·1	·683	65·64	12·3	12·1	....	15·4	140·7	20·45	217·00
21	97·2	....	....	....	....	....	....	....	24·00	241·00
22	96·8	·685	66·31	12·3	12·1	....	15·4	141·3	24·00	265·00
23	97·2	....	....	....	....	....	....	....	24·00	289·00
24	97·0	·683	66·25	11·7	11·5	....	14·6	142·0	24·00	313·00
*25	97·2	·685	66·58	10·9	10·7	....	13·6	141·9	24·00	337·00
26	96·8	....	....	....	....	....	....	....	21·00	358·00
*27	96·7	·681	65·85	10·5	10·3	....	13·1	142·0	24·00	382·00
*28	97·0	·683	66·25	9·6	9·4	....	11·9	142·0	24·00	406·00
*29	96·8	·682	66·01	9·6	9·4	....	11·9	141·9	24·00	430·00
30	96·7	·682	65·95	11·7	11·5	....	14·6	141·8	24·00	454·00
May.										
1	97·3	·682	66·35	12·2	12·0	....	15·2	142·7	24·00	478·00
2	97·0	·681	66·05	12·0	11·8	....	15·0	142·4	24·00	502·00
3	97·1	....	....	....	....	....	....	....	24·00	526·00
4	97·1	....	....	....	....	....	....	....	24·00	550·00
5	97·0	·682	66·15	12·0	11·8	....	15·0	142·2	24·00	574·00
6	97·1	·678	65·83	11·4	11·2	....	14·2	143·2	23·30	597·30
7	96·9	....	....	....	....	....	....	....	24·00	621·30
8	96·9	·677	65·60	11·8	11·6	....	14·7	143·1	24·00	645·30
9	97·1	·677	65·74	11·6	11·4	....	14·5	143·4	24·00	669·30
10	96·9	....	....	....	....	....	....	....	24·00	693·30
11	96·9	·675	65·40	11·1	10·9	....	13·8	143·6	24·00	717·30
12	97·1	....	....	....	....	....	....	....	24·00	741·30
13	97·3	....	....	....	....	....	....	....	23·30	765·00
14	97·2	·676	65·70	10·3	10·0	....	12·7	143·8	24·00	789·00
15	97·1	....	....	....	....	....	....	....	24·00	813·00
16	97·2	·675	65·61	11·2	11·0	....	14·0	144·0	24·00	837·00
17	87·3	....	....	....	....	....	....	....	24·00	861·00
18	97·2	·674	65·51	11·5	11·3	....	14·4	144·2	24·00	885·00
19	97·1	·672	65·25	10·2	10·0	....	12·7	144·5	24·00	909·00
20	97·0	....	....	....	....	....	....	....	24·00	933·00
21	97·0	·669	64·89	10·8	10·6	....	13·5	145·0	24·00	957·00
22	97·6	....	....	....	....	....	....	....	24·00	981·00
23	96·6	·661	64·14	9·7	9·5	....	12·1	145·5	24·00	1,005·00
24	96·8	....	....	....	....	....	....	....	24·00	1,029·00
*25	96·9	·667	64·63	7·5	7·4	....	9·4	145·3	24·00	1,053·00
26	....	....	....	....	....	....	....	....	11.30	1,064·30
27	....	....	....	....	....	....	....	....	....	....

Resistance Cold, 259. Discoloration, 2.

Edison Lamp, No. 11, 98 Volts.

(Reduction Factor, 0·91. Resistance Cold, 250.)

Date.	Volts.	Amperes.	Watts.	Candles. Observed.	Candles. Spherical.	Watts per Spher. Cand.	Candles. Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
1885 April.	98·7	·711	70·18	18·25	16·66	4·21	20·98	138·8	0·45	0·45
11				16·6	15·1		19·0		3·45	4·30
12									24·00	28·30
13	97·5	·692	67·47	14·5	13·2		10·5	110·0	24·00	52·30
14	98·3								24·00	76·30
15	97·8	·693	67·63	16·7	13·2		19·2	110·8	24·00	100·30
16	98·9								24·00	124·30
17	97·7	·681	67·41	14·8	13·5		17·0	111·0	24·00	148·30
18	97·3	·687	67·19	16·0	15·1		19·0	112·4	24·00	172·30
19	99·6								24·00	196·30
20	97·0	·680	65·96	14·5	13·2		16·6	112·0	20·45	217·15
21	97·7								24·00	241·15
22	97·8	·690	66·50	14·5	13·2		16·6	143·8	24·00	265·15
23	97·9								24·00	289·15
24	97·5	·675	65·81	12·5	11·4		14·4	144·4	24·00	313·15
*25	98·0	·674	66·03	11·5	10·5		13·2	143·4	24·00	337·15
26	98·0								21·00	358·15
*27	97·6	·672	65·58	11·8	10·7		13·5	145·2	24·00	382·15
*28	97·8	·673	65·82	10·6	9·6		12·1	145·3	24·00	406·15
*29	97·8	·667	65·23	10·1	9·2		11·6	146·6	24·00	430·15
30	97·6	·673	65·88	13·2	12·0		15·5	145·0	24·00	454·15
May.										
1	97·5	·667	65·03	13·1	11·9		15·0	146·2		
2	97·7	·668	65·26	12·6	11·5		14·5	146·3	24·00	478·15
3	98·0								24·00	502·15
4	98·0								24·00	526·15
5	97·9	·666	65·30	13·0	11·8		14·0	146·6	24·00	550·15
6	98·0	·666	65·28	12·1	11·0		13·0	147·2	24·00	574·15
7	97·6	·662	64·61	12·3	11·2		14·1	147·4	23·30	597·45
8	98·1								24·00	621·45
9	97·9	·664	65·01	12·4	11·3		14·2	147·4	24·00	645·45
10	97·7								24·00	669·45
11	97·8	·662	64·74	11·5	10·5		13·2	147·7	24·00	693·45
12	97·8								24·00	717·45
13	97·9								24·00	741·45
14	98·0	·662	64·87	11·5	10·5		13·3	148·0	23·30	765·15
15	98·0								24·00	789·15
16	97·6	·659	64·31	12·1	11·0		13·9	148·1	24·00	813·15
17	97·9								24·00	837·15
18	97·7	·660	64·18	12·0	10·9		13·7	148·0	24·00	861·15
19	97·8	·658	64·35	10·3	9·4		11·8	148·6	24·00	885·15
20	97·9								24·00	909·15
21	97·8	·656	64·15	11·4	10·1		13·1	149·1	24·00	933·15
22	97·9								24·00	957·15
23	97·6	·653	63·73	10·4	9·5		12·0	149·5	24·00	981·15
24	97·9								24·00	1,005·15
*25	97·9	·650	64·31	8·0	7·3		9·2	148·6	24·00	1,029·15
26									24·00	1,053·15
28									11·30	1,064·45

Resistance Cold, 200. Discoloration, 3.

Edison Lamp, No. 12, 98 Volts.

(Reduction Factor, 0·93. Resistance Cold, 254.)

Date.	Volts.	Amperes.	Watts.	Candles. Observed.	Candles. Spherical.	Watts per Spher. Cand.	Candles, Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
1885. April.	98·6	·686	67·77	14·72	13·76	4·92	17·48	141·0	1·00	1·00
11				16·4	15·3		19·1		3·45	4·45
12									24·00	28·45
13	97·2	·660	65·02	13·0	12·1		15·4	145·3	24·00	52·45
14	98·0								24·00	76·45
15	97·4	·671	65·35	14·7	13·7		17·4	145·2	24·00	100·45
16	98·1								24·00	124·45
17	97·5	·669	65·21	12·7	11·8		15·0	145·7	24·00	148·45
18	97·6	·671	65·49	14·7	13·7		17·4	145·5	24·00	172·45
19	99·5								24·00	196·45
20	98·9	·664	64·34	13·2	12·3		15·6	145·9	20·45	217·30
21	98·0								24·00	241·30
22	97·0	·669	65·50	12·9	12·0		15·2	146·3	24·00	265·30
23	98·2								24·00	289·30
24	97·9	·667	65·39	12·0	11·2		14·2	146·8	24·00	313·30
*25	98·1	·666	65·33	11·7	10·9		13·8	147·3	24·00	337·30
26	97·9								21·00	358·30
*27	97·8	·668	65·33	11·8	11·0		14·0	146·4	24·00	382·30
*28	98·0	·670	65·28	9·7	9·0		11·4	147·2	24·00	406·30
*29	97·8	·660	64·54	9·9	9·2		11·7	148·2	24·00	430·30
30	97·8	·664	64·94	13·0	12·1		15·4	147·3	24·00	454·30
May.										
1	98·0	·663	64·97	12·6	11·7		14·9	147·8		
2	97·7	·665	64·97	12·3	11·4		14·5	146·9	24·00	478·30
3	97·8								24·00	502·30
4	97·7								24·00	526·30
5	97·9	·660	64·61	13·2	12·3		15·6	148·3	24·00	550·30
6	97·8	·658	64·35	11·1	10·6		13·5	148·6	24·00	574·30
7	97·6	·657	64·12	12·1	11·3		14·4	148·6	23·30	598·00
8	97·8								24·00	622·00
9	97·8	·658	64·35	12·8	11·9		15·1	148·6	24·00	646·00
10	97·6								24·00	670·00
11	97·8	·659	64·45	11·6	10·8		13·7	148·4	24·00	694·00
12	97·7								24·00	718·00
13	98·0								24·00	742·00
14	97·9	·656	64·22	11·1	10·3		13·1	149·2	23·30	765·30
15	97·9								24·00	789·30
16	97·7	·653	63·79	11·5	10·7		13·6	149·6	24·00	813·30
17	97·8								24·00	837·30
18	97·8	·653	63·86	11·9	11·1		14·1	149·8	24·00	861·30
19	97·7	·654	63·80	10·1	9·4		11·9	149·4	24·00	885·30
20	97·6								24·00	909·30
21	98·0	·653	63·99	11·5	10·7		13·6	150·1	24·00	933·30
22	98·1								24·00	957·30
23	97·6	·649	63·31	10·7	10·0		12·7	150·4	24·00	981·30
24	97·9								24·00	1,005·30
*25	97·8	·652	63·76	8·1	7·5		9·5	150·0	24·00	1,029·30
26									24·00	1,053·30
28									11·30	1,065·00

Resistance Cold 268. Discoloration, 2.

Edison Lamp, No. 13, 96 Volts.

(Reduction Factor, 0·93. Resistance Hot, 235.)

Date.	Volts.	Amperes.	Watts.	Candles.		Watts per Spher. Cand.	Mean Horizontal Candles.	Resistance Hot.	Hours.	Total Hours.
				Observed.	Spherical.					
1885. April.	96·7	·723	69·91	16·67	15·44	4·52	19·00	133·7	0·30	0·30
11				15·6	14·5		17·8		3·45	4·15
12									24·00	28·15
13	95·0	·700	66·50	14·0	13·0		16·0	133·7	24·00	52·15
14	95·9								24·00	76·15
15	95·4	·705	67·26	15·1	14·0		17·2	133·8	24·00	100·15
16	95·9								24·00	124·15
17	95·4	·710	67·73	14·3	13·2		16·4	131·4	24·00	148·15
18	95·9	·710	68·09	16·3	15·2		18·7	135·1	24·00	172·15
19	97·4								24·00	196·15
20	95·2	·705	67·12	13·4	12·3		15·4	133·0	20·45	217·00
21	96·1								24·00	241·00
22	95·9	·706	67·70	13·8	12·6		15·7	133·8	24·00	265·00
23	96·2								24·00	289·00
24	95·8	·702	67·25	12·2	11·3		13·9	136·5	24·00	313·00
*25	96·0	·703	67·48	11·5	10·7		13·2	136·6	24·00	337·00
26	95·9								21·00	358·00
*27	95·9	·702	67·32	11·6	10·8		13·3	136·6	24·00	382·00
*28	95·9	·700	67·18	10·5	9·8		12·1	137·0	24·00	406·00
*29	95·8	·700	67·06	10·1	9·4		11·6	136·9	24·00	430·00
30	95·8	·702	67·25	12·9	12·0		14·8	136·5	24·00	454·00
May.										
1	96·0	·698	67·00	12·5	11·6		14·3	137·5	24·30	478·00
2	95·8	·699	66·96	12·4	11·5		14·1	137·1	24·00	502·00
3	93·9								24·00	526·00
4	95·1								24·00	550·00
5	96·0	·700	67·20	12·7	11·8		14·5	137·1	24·00	574·00
6	96·3	·699	67·31	11·8	11·0		13·5	137·8	23·30	597·30
7	96·0	·696	66·81	12·8	11·4		14·0	137·9	24·00	621·30
8	96·2								24·00	645·30
9	96·2	·697	67·05	12·5	11·6		14·3	138·0	24·00	669·30
10	96·1								24·00	693·30
11	96·0	·695	66·71	11·5	10·7		13·2	138·1	24·00	717·30
12	96·1								24·00	741·30
13	96·1								23·30	765·00
14	96·1	·696	66·78	11·4	10·6		13·0	138·3	24·00	789·00
15	96·2								24·00	813·00
16	96·2	·693	66·66	11·6	10·8		13·3	138·8	24·00	837·00
17	96·1								24·00	861·00
18	96·2	·691	66·47	12·0	11·2		13·8	139·2	24·00	885·00
19	96·1	·693	66·59	9·8	9·1		11·2	138·7	24·00	909·00
20	96·1								24·00	933·00
21	96·2	·689	66·28	11·4	10·6		13·0	139·6	24·00	957·00
22	96·2								24·00	981·00
23	95·8	·687	65·81	10·6	9·9		12·2	139·4	24·00	1,005·00
24	96·2								24·00	1,029·00
*25	96·1	·.89	65·21	8·3	7·7		9·5	139·5	24·00	1,053·00
26									11·30	1,064·30
28										

Resistance Cold, 247. Discoloration, 2½.

Edison Lamp, No. 14, 96 Volts.

(Reduction Factor, 0·94. Resistance Cold, 245.)

Date.	Volts.	Amperes.	Watts.	Candles.		Watts per Spher. Cand.	Candles, Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
				Observed.	Spherical.					
1885. April.	96·7	·707	68·37	16·63	15·62	4·37	19·70	136·8	0·30	0·30
11				17·4	16·4		20·7		3·45	4·15
12									24·00	28·15
13	95·3	·690	65·76	14·0	13·2		16·6	138·1	24·00	52·15
14	96·2								24·00	76·15
15	95·7	·690	66·61	15·2	14·3		18·0	137·5	24·00	100·15
16	96·3								24·00	124·15
17	95·9	·693	66·46	14·4	13·6		17·1	138·4	24·00	148·15
18	96·3	·697	67·12	15·7	14·8		18·6	138·2	24·00	172·15
19	97·6								24·00	196·15
20	95·3	·687	65·47	13·1	12·3		15·5	138·7	20·45	217·00
21	96·9								24·00	241·00
22	95·9	·685	65·69	13·1	12·3		15·5	140·0	24·00	265·00
23	96·3								24·00	289·00
24	96·1	·681	65·41	12·0	11·3		14·2	141·1	24·00	313·00
*25	96·2	·688	66·18	11·3	10·6		13·4	139·8	24·00	337·00
26	96·2								21·00	358·00
*27	96·0	·680	65·28	11·0	10·3		13·0	141·2	24·00	382·00
*28	96·2	·680	65·41	10·1	9·5		12·0	141·5	24·00	406·00
*29	96·3	·681	65·58	10·3	9·7		12·2	141·4	24·00	430·00
30	96·4	·680	65·55	12·9	12·1		15.2	141·8	24·00	454·00
May.										
1	96·1	·677	65·06	12·4	11·7		14·7	141·9	24·00	478·00
2	96·1	·679	65·25	11·9	11·2		14·1	141·5	24·00	502·00
3	96·1								24·00	526·00
4	96·1								24·00	550·00
5	96·1	·677	65·06	12·8	11·6		14·6	141·9	24·00	574·00
6	96·3	·674	64·90	11·5	10·8		13·6	142·0	23·30	597·30
7	96·0	·670	64·31	12·0	11·3		14·2	143·3	24·00	621·30
8	96·1								24·00	645·30
9	96·3	·671	64·62	12·3	11·6		14·6	143·5	24·00	669·30
10	96·3								24·00	693·30
11	96·0	·669	64·22	11·3	10·6		13·4	143·5	24·00	717·30
12	96·0								24·00	741·30
13	96·8								23·30	765·00
14	96·1	·670	64·88	10·8	10·2		12·9	143·4	24·00	789·00
15	96·3								24·00	813·00
16	96·0	·667	64·03	11·0	10·3		13·0	143·9	24·00	837·00
17	96·5								24·00	861·00
18	95·7	·663	63·44	11·1	10·4		13·1	144·3	24·00	885·00
19	95·7	·662	63·35	9·4	8·8		11·1	144·6	24·00	909·00
20	95·8								24·00	933·00
21	95·7	·660	63·16	10·6	10·0		12·6	145·0	24·00	957·00
22	96·0								24·00	981·00
23	95·7	·658	62·97	9·7	9·1		11·5	145·4	24·00	1,005·00
24	95·9								24·00	1,029·00
*25	95·8	·659	63·13	7·7	7·2		9·1	145·4	24·00	1,053·00
26									11·30	1,064·00
28										

Resistance Cold, 260. Discoloration, 3.

Edison Lamp, No. 15, 99 Volts.

(Reduction Factor, 1·09. Resistance Cold, 2·55.)

Date.	Volts.	Amperes.	Watts.	Candles Observed	Candles Spherical.	Watts per Spher. Cand.	Candles. Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
1885. April.	99·7	·692	68·99	14·30	15·65	4·40	19·74	144·1	0·30	0·30
11	....	....	....	14·4	15·7	....	19·8	....		
12	....								3·45	4·15
13	98·1	·692	67·94	11·2	12·3	....	15·5	143·2	24·00	28·15
14	99·1	....	....						24·00	52·15
15	98·5	·667	65·70	12·4	13·5	....	17·0	147·7	24·00	76·15
16	99·0								24·00	100·15
17	98·9	·671	66·36	11·5	12·5	....	15·8	147·4	24·00	124·15
18	98·9	·674	66·65	12·5	13·6	....	17·1	146·7	24·00	148·15
19	100·1								24·00	172·15
20	98·1	·666	65·34	11·2	12·2	....	15·4	147·3	24·00	196·15
21	99·8								20·45	217·00
22	98·8	·665	65·71	11·2	12·2	....	15·4	148·6	24·00	241·00
23	99·4	....	....	....	....	....	....	....	24·00	265·00
24	....	....	....	....	....	....	....	....	24·00	289·00
									6·00	295·00

Carbon broke at side of loop 6.00 A. M., April 24, 1885. Discoloration, 2.

Edison Lamp, No. 16, 95 Volts.

(Reduction Factor, 0·79. Resistance Cold, 239.)

Date.	Volts.	Amperes.	Watts.	Candles. Observed.	Candles. Spherical.	Watts per Spher. Cand.	Candles. Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
1885. April.	95·7	·714	68·33	20·30	16·00	4·24	20·26	134·0	0·30	0·30
11	....	....	....	19·0	15·0	....	18·9	....	3·45	4·15
12	....								24·00	28·15
13	94·1	·689	64·84	16·2	12·8	....	16·1	136·6	24·00	52·15
14	95·2								24·00	76·15
15	94·0	·696	66·05	17·2	13·6	....	17·1	136·4	24·00	100·15
16	95·0								24·00	124·15
17	95·1	·696	66·19	15·7	12·4	....	15·6	136·6	24·00	148·15
18	95·8	·699	66·96	17·1	13·5	....	17·0	137·1	24·00	172·15
19	95·9								24·00	196·15
20	94·2	·689	64·90	15·7	12·4	....	15·6	136·7	20·45	217·00
21	96·0								24·00	241·00
22	95·0	·687	65·27	15·1	11·9	....	15·0	138·3	24·00	265·00
23	95·2								24·00	289·00
24	95·2	·685	65·21	14·1	11·1	....	14·0	139·0	24·00	313·00
*25	95·1	·681	65·04	12·7	10·0	....	12·6	139·0	24·00	337·00
26	95·2								21·00	358·00
*27	95·1	·682	64·85	12·8	10·1	....	12·7	139·4	24·00	382·00
*28	95·0	·682	64·79	11·6	9·2	....	11·7	139·3	24·00	406·00
*29	95·1	·682	64·85	11·5	9·1	....	11·5	139·4	24·00	430·00
30	95·1	·684	65·04	14·6	11·5	....	14·5	139·0	24·00	454·00
May.										
1	95·0	·678	64·41	14·3	11·3	....	14·2	140·1	24·00	478·00
2	95·0	·678	64·41	13·9	11·0	....	13·9	140·1	24·00	502·00
3	95·1	....	....	....	....	....	....	....	24·00	526·00
4	95·1	....	....	....	....	....	....	....	24·00	550·00
5	95·0	·679	64·50	14·8	11·7	....	14·7	139·0	24·00	574·00
6	95·0	·677	64·31	12·9	10·2	....	12·9	140·3	23·30	597·30
7	94·9	·670	63·58	13·5	10·7	....	13·5	141·6	24·00	621·30
8	95·0								24·00	645·30
9	95·1	·674	64·10	13·7	10·8	....	13·6	141·1	24·00	669·30
10	94·9								24·00	693·30
11	94·9	·671	63·67	12·5	9·9	....	12·5	141·4	24·00	717·30
12	94·8								23·00	741·30
13	95·1	....	....	....	....	....	....	....	23·30	765·00
14	95·0	·671	63·74	12·1	9·6	....	12·1	141·6	24·00	789·00
15	95·3								24·00	813·00
16	94·9	·670	63·58	13·1	10·3	....	13·0	141·6	24·00	837·00
17	95·3								24·00	861·00
18	95·0	·669	63·55	12·7	10·0	....	12·6	142·0	24·00	885·00
19	94·9	·669	63·48	11·2	8·8	....	11·1	141·9	24·00	909·00
20	94·7								24·00	933·00
21	95·2	·667	63·50	12·0	9·5	....	12·0	142·7	24·00	957·00
22	95·1								24·00	981·00
23	94·7	·664	62·88	11·5	9·1	....	11·5	142·6	24·00	1,005·00
24	95·0								24·00	1,029·00
*25	94·8	·665	63·01	8·9	7·0	....	8·8	142·6	24·00	1,053·00
26	....	....	....	....	....	....	....	....	11·30	1,064·30
28	....	....	....	....	....	....	....	....	....	....

Resistance Cold, 256. Discoloration, 2½.

Edison Lamp, No. 17, 98 Volts.

(Reduction Factor, 0·92. Resistance Cold, 259.)

Date.	Volts.	Amperes.	Watts.	Candles.		Watts per Spher. Cand.	Candles. Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
				Observed.	Spherical.					
1882. April.	98·8	·701	69·26	17·98	16·61	4·17	21·10	140·9	1·00	1·00
11	...	...	...	16·8	15·5	...	19·7	...	3·45	4·45
12	...	...	...	...	...	...	...	...	24·00	28·45
13	98·0	·679	65·79	15·1	13·9	...	17·7	142·7	24·00	52·45
14	98·0	...	...	...	...	...	...	...	24·00	76·45
15	97·6	·682	66·56	15·8	14·1	...	17·9	143·1	24·00	100·45
16	98·0	...	...	...	...	...	...	...	24·00	124·45
17	98·0	·685	67·13	14·7	13·5	...	17·1	143·1	24·00	148·45
18	98·4	·684	67·31	15·0	14·6	...	18·5	143·9	24·00	172·45
19	99·0	...	...	...	...	...	...	...	24·00	196·45
20	98·5	·681	67·08	15·1	13·9	...	17·7	144·6	20·45	217·30
21	99·0	...	...	...	...	...	...	...	24·00	241·30
22	98·1	·675	66·22	13·7	12·6	...	16·0	145·3	24·00	265·30
23	98·4	...	...	...	...	...	...	...	24·00	289·30
24	98·3	·670	65·86	12·6	11·6	...	14·7	146·7	24·00	313·30
25	98·5	·672	66·19	11·5	10·6	...	13·5	146·6	24·00	337·30
26	98·5	...	...	...	...	...	...	...	21·00	358·30
27	98·4	·666	65·53	11·3	10·4	...	13·2	147·8	24·00	382·30
28	97·8	·661	64·64	10·1	9·3	...	11·8	148·0	24·00	406·30
29	98·0	·661	64·77	9·6	8·8	...	11·2	148·3	24·00	430·30
30	98·1	·660	64·74	12·0	11·0	...	14·0	148·6	21·00	451·30
May.										
1	98·0	·656	64·28	12·1	11·1	...	14·1	149·4	24·00	478·30
2	97·9	·655	64·12	11·5	10·0	...	13·5	149·5	24·00	502·30
3	97·9	...	...	...	...	...	...	...	24·00	526·30
4	98·1	...	...	...	...	...	...	...	24·00	550·30
5	97·8	·650	63·57	11·5	10·6	...	13·5	150·5	24·00	574·30
6	97·9	·651	63·73	10·7	9·8	...	12·4	150·4	23·30	598·00
7	97·7	·648	63·31	10·9	10·0	...	12·7	150·8	24·00	622·00
8	97·9	...	...	...	...	...	...	...	24·00	646·00
9	97·9	·648	63·44	11·7	10·8	...	13·7	151·1	24·00	670·00
10	97·8	...	...	...	...	...	...	...	24·00	694·00
11	97·7	·648	63·31	10·6	9·8	...	12·4	150·8	24·00	718·00
12	97·7	...	...	...	...	...	...	...	24·00	742·00
13	98·4	...	...	...	...	...	...	...	23·30	765·30
14	98·0	·647	63·40	10·5	9·7	...	12·3	151·5	24·00	789·30
15	97·9	...	...	...	...	...	...	...	24·00	813·30
16	97·7	·650	63·50	10·6	9·8	...	12·4	150·3	24·00	837·30
17	98·1	...	...	...	...	...	...	...	24·00	861·30
18	98·0	·644	63·11	10·8	9·9	...	12·6	152·2	24·00	885·30
19	97·8	·643	62·88	8·8	8·1	...	10·3	152·1	24·00	909·30
20	97·9	...	...	...	...	...	...	...	24·00	933·30
21	98·0	·640	62·72	10·3	9·5	...	12·1	153·1	24·00	957·30
22	98·1	...	...	...	...	...	...	...	24·00	981·30
23	97·6	·638	62·26	9·5	8·7	...	11·0	153·0	24·00	1,005·30
24	97·8	...	...	...	...	...	...	...	24·00	1,029·30
25	97·9	·639	62·55	7·5	6·9	...	8·8	153·2	24·00	1,053·30
26	...	...	...	...	...	...	...	...	11·30	1,065·00
	...	...	...	...	...	...	...	...	...	...

Resistance Cold, 280. Discoloration, 3.

Edison Lamp, No. 18, 97 Volts.

(Reduction Factor, 0·96. Resistance Cold, 242.)

Date.	Volts.	Amperes.	Watts.	Candles.		Watts per Spher. Cand.	Candles. Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
				Observed.	Spherical.					
1885. April.	97·7	·708	69·17	16·34	15·60	4·43	19·25	138·0	0·30	0·30
11	...	...	...	13·6	13·1	...	16·1	...	3·45	4·15
12	...	...	...	...	...	...	...	...	24·00	28·15
13	95·8	·669	64·00	11·2	10·7	...	13·2	143·2	24·00	52·15
14	97·1	...	...	...	...	...	...	...	24·00	76·15
15	96·5	·674	65·01	12·0	11·5	...	14·1	143·2	24·00	100·15
16	97·0	...	...	...	...	...	...	...	24·00	124·15
17	96·9	·681	65·99	10·9	10·5	...	12·9	142·3	24·00	148·15
18	97·5	·682	66·50	13·0	12·5	...	15·4	143·0	24·00	172·15
19	97·7	...	...	...	...	...	...	...	24·00	196·15
20	97·4	·682	66·43	12·2	11·7	...	14·4	142·8	20·45	217·00
21	97·7	...	...	...	...	...	...	...	24·00	241·00
22	96·9	·678	65·70	11·3	10·8	...	13·3	142·9	24·00	265·00
23	96·9	...	...	...	...	...	...	...	24·00	289·00
24	96·9	·671	65·02	10·0	9·6	...	11·8	144·4	24·00	313·00
25	97·0	·676	65·57	9·5	9·1	...	11·2	143·5	24·00	337·00
26	96·8	...	...	...	...	...	...	...	21·00	358·00
27	97·0	·677	65·66	9·6	9·2	...	11·3	143·3	24·00	382·00
28	96·8	·671	64·95	8·4	8·1	...	10·0	144·3	24·00	406·00
29	97·0	·671	65·08	8·7	8·1	...	10·3	144·6	24·00	430·00
30	97·1	·673	65·34	10·9	10·5	...	12·9	144·3	21·00	451·00
May.										
1	96·8	·670	64·85	10·8	10·4	...	12·8	144·5	24·00	478·00
2	96·7	·669	64·69	10·5	10·1	...	12·4	144·5	24·00	502·00
3	96·9	...	...	...	...	...	...	...	24·00	526·00
4	97·2	...	...	...	...	...	...	...	24·00	550·00
5	96·9	·674	65·31	11·1	10·7	...	13·2	143·8	24·00	574·00
6	97·0	·669	64·89	10·0	9·6	...	11·8	145·0	23·30	597·30
7	96·8	·670	64·85	10·8	10·4	...	12·8	144·5	24·00	621·30
8	96·9	...	...	...	...	...	...	...	24·00	645·30
9	97·0	·671	65·08	11·0	10·6	...	13·0	144·6	24·00	669·30
10	97·0	...	...	...	...	...	...	...	24·00	693·30
11	96·8	·671	64·95	10·3	9·9	...	12·2	144·3	24·00	717·30
12	95·9	...	...	...	...	...	...	...	24·00	741·30
13	97·4	...	...	...	...	...	...	...	23·30	765·00
14	97·2	·673	65·41	9·9	9·5	...	11·7	144·4	24·00	789·00
15	97·3	...	...	...	...	...	...	...	24·00	813·00
16	97·0	·671	65·08	10·3	9·9	...	12·2	144·6	24·00	837·00
17	97·2	...	...	...	...	...	...	...	24·00	861·00
18	97·0	·668	64·79	10·4	10·0	...	12·3	145·2	24·00	885·00
19	97·1	·669	64·96	8·7	8·4	...	10·3	145·1	24·00	909·00
20	97·2	...	...	...	...	...	...	...	24·00	933·00
21	97·0	·666	64·60	10·1	9·7	...	11·9	145·6	24·00	957·00
22	97·2	...	...	...	...	...	...	...	24·00	981·00
23	97·3	·664	64·60	9·5	9·1	...	11·2	146·5	24·00	1,005·00
24	97·0	...	...	...	...	...	...	...	24·00	1,029·00
25	97·0	·668	64·79	7·4	7·1	...	8·7	145·2	24·00	1,053·00
26	...	...	...	...	...	...	...	...	11·30	1,064·30
28	...	...	...	...	...	...	...	...	...	...

Resistance Cold, 256. Discoloration, 2½.

Edison Lamp, No. 19, 99 Volts.

(Reduction Factor, 0·99. Resistance Cold, 250.)

Date.	Volts.	Amperes.	Watts.	Candles. Observed.	Candles. Spherical.	Watts per Spher. Cand.	Candles, Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
1885. April.	99·7	·714	71·19	16·15	16·02	4·44	19·50	139·6	0·45	0·45
11				10·4	10·3		12·6		3·45	4·30
12									24·00	28·30
13	97·8	·681	66·60	11·9	11·8		14·1	143·6	24·00	52·30
14	99·0								24·00	76·30
15	98·5	·683	67·28	12·4	12·3		15·0	144·2	24·00	100·30
16	99·1								24·00	124·30
17	99·0	·688	68·11	11·8	11·7		14·3	144·9	24·00	148·30
18	99·5	·692	68·86	12·0	12·8		15·6	143·8	24·00	172·30
19	99·8								24·00	196·30
20	97·8	·670	65·53	11·0	10·9		13·3	146·0	20·45	217·15
21	100·0								24·00	241·15
22	99·9	·681	67·35	11·5	11·1		13·9	145·2	24·00	265·15
23	99·1								24·00	289·15
24	99·0	·679	67·22	9·9	9·8		12·0	145·8	24·00	313·15
25	99·4	·680	67·50	10·1	10·0		12·2	146·2	24·00	337·15
26	99·2								21·00	358·15
27	99·0	·679	67·22	9·2	9·1		11·1	145·8	24·00	382·15
28	99·0	·674	66·72	8·7	8·6		10·5	146·9	24·00	406·15
29	99·2	·678	67·25	8·8	8·7		10·6	146·3	24·00	430·15
30	99·2	·676	67·08	10·9	10·8		13·2	146·7	24·00	454·15
May.										
1	99·0	·673	66·62	11·3	11·2		13·7	147·1	24·00	478·15
2	99·0	·674	66·72	11·2	11·1		13·5	146·9	24·00	502·15
3	99·0								24·00	526·15
4	99·4								24·00	550·15
5	99·3	·667	66·23	11·6	11·5		11·0	148·9	24·00	574·15
6	99·3	·671	66·63	10·2	10·1		12·3	148·0	23·30	597·45
7	99·1	·669	66·29	10·5	10·4		12·7	148·1	24·00	621·45
8	99·2								24·00	645·45
9	99·1	·670	66·40	11·0	10·9		13·3	147·9	24·00	669·45
10	99·2								24·00	693·45
11	99·0	·666	65·93	10·1	10·0		12·2	148·7	24·00	717·45
12	99·0								24·00	741·45
13	99·6								23·30	765·15
14	99·2	·667	66·16	9·8	9·7		11·8	148·7	24·00	789·15
15	99·3								24·00	813·15
16	99·0	·668	66·13	10·3	10·2		12·4	148·2	24·00	837·15
17	99·1								24·00	861·15
18	99·1	·666	66·00	10·3	10·2		12·4	148·8	24·00	885·15
19	99·1	·665	65·90	8·8	8·5		10·4	149·0	24·00	909·15
20	99·1								24·00	933·15
21	99·4	·661	66·00	10·1	10·0		12·2	149·7	24·00	957·15
22	99·3								24·00	981·15
23	99·1	·661	65·50	9·7	9·6		11·7	149·9	24·00	1,005·15
24	99·1								24·00	1,029·15
25	99·0	·662	65·53	7·4	7·3		8·9	149·5	24·00	1,053·15
26									11·30	1,064·45
27										
28										

Resistance Cold, 267. Discoloration, 2¼.

Edison Lamp, No. 20, 100 Volts.

(Reduction Factor, 0·97. Resistance Cold, 256.)

Date.	Volts.	Amperes.	Watts.	Candles. Observed.	Candles. Spherical.	Watts per Spher. Cand.	Candles, Mean Horizontal.	Resistance Hot.	Hours.	Total Hours.
1885. April.	100·7	·696	70·09	16·23	15·82	4·43	19·56	144·7	0·30	0·30
11				15·5	15·0		18·6		3·45	4·15
12									24·00	28·15
13	98·6	·669	65·96	12·3	12·0		14·9	147·1	24·00	52·15
14	100·0								24·00	76·15
15	99·5	·669	66·57	13·0	12·6		15·6	148·7	24·00	100·15
16	100·4								24·00	124·15
17	99·7	·671	67·20	12·5	12·2		15·1	147·9	24·00	148·15
18	100·4	·677	67·07	13·9	13·5		16·7	148·3	24·00	172·15
19	100·4								24·00	196·15
20	98·5	·666	65·60	11·4	11·1		13·8	147·3	20·45	217·00
21	100·6								24·00	241·00
22	100·0	·673	67·30	12·2	11·8		14·6	148·6	24·00	265·00
23	100·5								24·00	289·00
24	100·2	·655	65·63	9·7	9·4		11·7	153·0	24·00	313·00
25	100·6	·650	66·29	9·4	9·1		11·3	152·7	24·00	337·00
26	100·7								21·00	358·00
27	100·3	·662	66·39	9·6	9·3		11·5	151·5	24·00	382·00
28	100·2	·653	65·43	8·7	8·4		10·4	153·4	24·00	406·00
29	100·1	·651	65·16	8·5	8·2		10·2	153·8	24·00	430·00
30	100·2	·651	65·53	10·6	10·3		12·8	153·2	24·00	454·00
May.										
1	100·1	·645	64·56	10·6	10·3		12·8	155·2	24·00	478·00
2	99·9	·639	64·13	10·3	10·0		12·4	153·7	24·00	502·00
3	99·9								24·00	526·00
4	99·8								24·00	550·00
5	99·9	·650	64·93	10·9	10·6		13·1	153·7	24·00	574·00
6	99·9	·648	64·73	10·1	9·8		12·2	154·2	23·30	597·30
7	99·6	·641	63·84	10·0	9·7		12·0	155·4	24·00	621·30
8	99·8								24·00	645·30
9	99·7	·646	64·41	10·5	10·2		12·6	154·3	24·00	669·30
10	100·0								24·00	693·30
11	99·6	·647	64·44	10·1	9·8		12·2	153·9	24·00	717·30
12	100·0								24·00	741·30
13	100·2								23·30	765·00
14	99·8	·643	64·17	9·5	9·2		11·4	155·2	24·00	789·00
15	99·9								24·00	813·00
16	99·7	·642	64·00	9·8	9·5		11·8	155·3	24·00	837·00
17	100·0								24·00	861·00
18	100·0	·639	63·90	9·9	9·6		11·9	156·5	24·00	885·00
19	99·5	·646	64·27	8·7	8·4		10·4	154·0	24·00	909·00
20	99·7								24·00	933·00
21	99·8	·642	64·07	9·9	9·6		11·9	155·5	24·00	957·00
22	99·9								24·00	981·00
23	99·9	·636	63·53	9·2	8·9		11·0	157·1	24·00	1,005·00
24	99·7								24·00	1,029·00
25	100·0	·637	63·70	6·9	6·7		8·3	157·0	24·00	1,053·00
26									11·30	1,064·30
27										
28										

Resistance Cold, 270. Discoloration, 2.

U. S. CIRCUIT COURT, 10721

SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT COMPANY, vs. THE UNITED STATES ELECTRIC LIGHTING COMPANY.	In Equity. No. 3445. 10722

Proofs for final hearing taken by the defendant in pursuance of the order of the Court entered October 10, 1890.

NEW YORK, Oct 15, 1890. 10723

Met pursuant to notice, at the offices of KERR & CURTIS, 120 Broadway, New York City.
Present:

GROSVENOR P. LOWREY, Esq. and RICHARD N. DYER, Esq., of counsel for complainant;
EDMUND WETMORE Esq., and LEONARD E. CURTIS, Esq., of counsel for defendant.

ALONSO C. BRACKETT, a witness, produced in behalf of the defendant having been duly sworn testifies in answer to questions propounded by Mr. Wetmore: 10724

1 Q. What is your name, age, residence and occupation?

A. My name is Alonzo Clifford Brackett, I am forty-six years old. I reside at 302 W. 29th Street,

10725 New York City. I am Superintendent of the New York Nickel Plating Manufacturing Company.

2 Q. How long have you been in the service of that Company?

A. About seven years.

3 Q. And how were you engaged before that time?

Q. With H. A. Tweed, in the same line of business. Previous to that with Green, Tweed & Co., and before that with the New York Nickel Plating Company:
10726 back of that with Smith, Phinney and Smith.

4 Q. Where was the place of business of Smith, Phinney & Smith, while you were with them?

A. 133 and 135 W. 25th, Street, New York City.

5 Q. Do you know Dr. Isaac Adams, formerly of Boston and now of Annisquam or Gloucester, Mass., who was the patentee of certain improvements in nickel plating?

A. Yes, sir.

6 Q. Do you remember seeing him at the said es-
10727 tablishment in 25th Street, and if so, in what year or years?

A. I seen him in '73, '74, '75, '76 and '77 several times in each year.

7 Q. Do you remember any particular occasion when Dr. Adams visited that establishment, and burned any electric lights there?

A. I do.

8 Q. In what year was that?

A. In 1873.

9 Q. What part of the business at that time was
10728 under your charge?

A. Receiving, delivering and billing goods.

10 Q. And where were your headquarters in the building?

A. On the first floor?

11 Q. In the office?

A. Yes, sir.

12 Q. Where were the lamp or lamps burned? 10729

A. In the rear part of the building, on the same floor.

13 Q. Did you examine the lamps or their construction?

A. No, sir; I did not!

14 Q. You have no recollection about them, except the fact that they were burned; and will you please state what you saw, so far as you remember in that respect?

A. I recollect Dr. Adams experimenting with these 10730
lamps, or with this lamp; I don't remember the number of lamps. I also recollect the light was dazzling to the eyes. I remember that distinctly, so dazzling I did not care to look at it

15 Q. Have you any recollection who if anybody was with Dr. Adams on any occasion when you saw the lamp burning?

A. I think that Mr. L. L. Smith, who is now dead, was with him on one occasion,

16 Q. Have you any recollection of more than one 10731
occasion when the lamp or lamps were burned?

A. No, sir; only this one time.

17 Q. Did Dr. Adams leave any lamp behind him after these experiments, to your knowledge?

A. Yes, sir.

18 Q. What became of it, so far as you know?

A. It remained in the shop until within two days.

19 Q. Please look at the lamp produced and shown you, and state whether it is the one to which you
refer? 10732

A. That is the one.

Lamp produced, offered in evidence, and marked "Defendant's Exhibit Adams Lamp, No. 1."

10733 *Cross-examination* BY MR. LOWREY:

20 x-Q. At the time when you saw Dr. Adams and his lamp, was he employed at the shops of your company, or was he in any way connected with the company, directly or indirectly?

A. He was not; the only way in which he was interested, was that we were licensees of the United Nickel Company, who were the owners of Dr. Isaac Adams' patents on nickel plating.

10734 21 x-Q. Whence was the current derived by which this lamp was actuated?

A. A dynamo manufactured by Wilder of England

22 x-Q. Was it a machine you used in nickel plating?

A. Yes, sir.

23 x-Q. Are you an electrician?

A. No, sir.

24 x-Q. Do you know, in fact, the electro-motive force of that dynamo?

A. No, sir.

10735 25 x-Q. Who was the Mr. L. L. Smith, to whom you referred as dead?

A. He was senior member of Smith, Phinney and Smith.

Cross-examination closed.

A. C. BRACKETT.

Adjournment until October 16th, 1890, at 11 A. M.

10736

October 16, 1890. Met pursuant to adjournment. 10737
Present:

GROSVENOR P. LOWREY AND RICHARD N. DYER, Esqrs.,
Of counsel for Complainant.

EDMUND WETMORE AND LEONARD E. CURTIS, Esqrs.,
Of counsel for Defendant.

DR. ISAAC ADAMS, a witness produced on behalf of the defendant, having first been duly sworn, testifies in answer to interrogatories by Mr. Wetmore, as follows: 10738

1 Q. What is your name, age, residence and occupation?

A. My name is Isaac Adams, I am fifty-four years old. I reside at Gloucester, Mass. I am not now in business.

In accordance with the suggestion of complainant's counsel, and to save time, defendant's counsel offers in evidence a copy of the affidavit of Dr. Adams used upon the motion to open 10739
the case for the purpose of taking said testimony.

2 Q. Please look at the copy affidavit herewith shown you, being a copy of your affidavit above referred to, and state whether or not the allegations therein contained are true, and you repeat the same for the purposes of this examination?

A. They are, and I do.

It is agreed that the following is a correct copy of 10740
the affidavit referred to:

STATE OF MASSACHUSETTS, }
COUNTY OF ESSEX, } ss.

ISAAC ADAMS, being duly sworn, deposes and says as follows:

10741

I am 54 years of age and reside at Gloucester in the
State of Massachusetts at present. I was educated as
a physician, having taken the degree of M. D. from
the Medical School of Harvard University. In the
years 1862, 1863 and 1864,subseqent to my graduation
at Harvard University, I was pursuing my medical
studies in Paris. While there I took great interest in
the general subjects of Chemistry and Physics, and in
connection with my work in this line devoted con-
10742 siderable time to acquiring a knowledge of the art
of glass blowing, in which I became very expert,
and of the construction and exhaustion of Geissler
tubes. Soon after my return to the United States
in the year 1864 I put my knowledge of the
art of glass blowing to practical use in the manu-
facture of Geissler tubes. I established a labora-
tory in South Boston for work in chemistry and
physics, and in 1865, and for some two or three years
thereafter, I, as a matter of business, made at that
10743 place a large number of Geissler tubes of various sizes
and designs which I sold principally to E S. Ritchie,
a well known philosophical instrument maker and
dealer in Boston. I also sold such tubes to the
Chester Bros., of New York City, and some of them
to Professor Cooke, of Harvard University. Among
other varieties of such tubes I made a considerable
number of so-called "perfect vacuum" tubes. In these
latter the vacuum was made as high as possible, being
in fact as high as any vacuum produced by any of
the apparatus of the present day.

10744 The apparatus which I used for producing the
vacuum in these tubes was a mercury pump which was a
modification of, and improvement upon, the well-
known Geissler Mercury Pump, and enabled me to
produce a better vacuum than could be made with the
ordinary Geissler pump. I believe that these Geissler
tubes made by me as above stated were the first ever

made in this country, and that the mercury pump 10745
which I used was the first mercury pump ever used
here.

Several years prior to this time, I had taken con-
siderable interest in the subject of electric lighting
generally, and had examined electric light apparatus
at Paris, and had invented and made a "regulator," or
an arc lamp as it is called at the present time, and had
experimented in making carbons for such lamps. My
experience in the manufacture of Geissler tubes led me, 10746
in the year 1865. to consider the question of construct-
ing an incandescent electric light. I had read of
experiments made by Grove and others with a view to
using incandescent platinum lamps for lighting mines,
and had to come to the conclusion that platinum
was not a suitable material for the burners of such
lamps, and that carbon was the proper material to be
used for that purpose. I was familiar with the prop-
erties of carbon, and believed that if a slip of carbon
were to be enclosed in a highly exhausted Geissler
tube, it would remain stable for a long time when 10747
brought to a high state of incandescence by the elec-
tric current.

In the year 1865 and the following year I made
several lamps, certainly as many as a dozen, which
consisted of a carbon burner enclosed in a glass globe
which was made precisely as I had made the Geissler
tubes before referred to and from which the air was
exhausted as completely as possible by means of the
mercury pump to which I have referred above. The
carbons of these lamps varied somewhat in dimensions, 10748
but their approximate dimensions were an inch to an
inch and a quarter in length, about 3-16 of an inch
in width, and from 5 to 10 one-thousandths of an
inch in thickness. I measured the thickness at the
time by means of a Brown & Sharpe micrometer gauge
in order to get each one of uniform thickness.

10749 These carbons were supported in a horizontal position by being clamped upon the ends of short copper or brass wires, which in turn were brazed to short lengths of smaller platinum wire. The size of the platinum wire was about No. 16 Birmingham wire gauge. These platinum wires passed through the lower part of the glass globe, and projected a short distance outside for connection to the wires leading to the battery. In order to secure an effective and
10750 durable seal at the point where the wires passed through the globe, so as to prevent leakage and thus maintain the vacuum, I first coated the platinum wires with glass by fusing on to the wire a short section of a small glass tube constituting a sleeve. The glass of the globe was then fused directly upon this sleeve. In that way I was able to secure a permanent seal at this point. In some of the lamps each of the wires was provided with a sleeve in this way and the two sleeves were fused into the globe separately; but in
10751 most of the lamps the two sleeves were fused together into one piece and this piece containing both of the platinum wires was sealed into the globe. After the wires had been sealed in, the globe was exhausted through a tubulure, or small glass tube, attached to the top of the globe and this tubulure, after exhaustion, was sealed off by fusing the glass in the same manner as the Geissler tubes were exhausted and sealed.

The carbons which I used in these lamps were produced in various ways. Sometimes I sawed and filed
10752 them into approximate shape from a piece of gas-retort carbon; at other times I cut them out from a block of plumbago; I also made use of leads taken from carpenter's pencils. Having brought the pieces of carbon to their approximate shape, I then ground the faces down to true surfaces by gluing them on to a flat surface and grinding down the exposed surface

with a stone. Other carbons I produced by Bunsen's method of making artificial carbons which consisted in making a mixture of lampblack and powdered coke and molasses, which was then compacted in a mold and thoroughly baked. The product was then dipped in a strong solution of sugar and baked again, this operation being repeated a number of times, until the resultant product was a substantially pure and very tough carbon. 10753

During the process of exhausting these lamps it was my practice, as it had been in the manufacture of Geissler tubes, to apply a high heat by means of a Bunsen burner to the exterior of the globe for the purpose of driving out any gases that might otherwise remain occluded in the globe or its contents. 10754

In testing and operating these lamps in the years above named I made use of a battery, employing sometimes as many as 30, 2-quart Bunsen cells. At other times a smaller battery than this was used. With his battery I was able to heat the carbon burner to a vivid incandescense, and when the lamp was well constructed, as was the case with a number of the lamps I made, I found that I was able to run it so as to give a good light for a long time without sensible deterioration of the carbon. 10755

I remember one lamp in particular, which I ran off and on for a period of about two years, and during that time I ran it at a high state of incandescence for at least 200 hours in all. This lamp was finally broken accidently, and was a good operative lamp with the carbon in good condition when the globe was broken. 10756

This last named lamp I took with me to Paris for the purpose of showing the same to M. Gaiffe, who was a well known manufacturer of electric apparatus. This was either in 1867 or 1869 and I cannot now remember in which year. I visited Paris in both of

10757

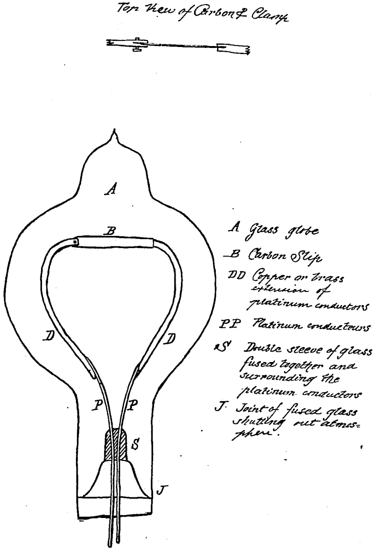
these years and have not been there since 1870, when I returned from the last of the visits I have referred to. I had known M. Gaiffe when a student in Paris, and it was through his instrumentality that I learned the art of glass blowing. My purpose is taking the lamp to him was to get his views in regard to the commercial value of the lamp. He tested it in his establishment at Paris by the use of a large battery and brought the carbon to a high state of incandescence.
10758 It operated perfectly well, and he agreed with me in the conclusions that I had already formed that the lamp was a practical and reliably durable lamp; but on account of the cost of producing the electric current by any means then in use, we came to the conclusion that there would be no commercial demand for such a lamp until some cheaper mode of producing the electric current was invented.

I showed the lamps on different occasions and described the same to various persons, among whom I
10759 would mention especially my brother Aquila Adams, who now lives in Sandwich, New Hampshire.

In the year 1868, I became absorbed in the exploitation of my patents on nickel plating and this and the prolonged litigation which ensued in relation to those patents, absorbed all my time and energy down to 1884

I did not apply for a patent on the lamp constructed by me in 1865 and 1866 as above described. It never occurred to me that there was anything patentable in making use of the Geissler-tube construction of globe
10760 for the protection of the carbon burner of an incandescent lamp. This seemed to me a most obvious expedient for this purpose and one that would naturally occur to any person skilled in the art.

I append to this affidavit a sketch that illustrates



the lamp which I made in 1865 and which is described above. 10761

Isaac Adams.

Subscribed and sworn to before me this 27th day of September, 1890.
Geo. E. Lane,
Justice of the Peace.

3 Q. Since making your affidavit, have you found any of your note-books containing contemporaneous memoranda in reference to the lamps made by you and referred to in said affidavit; and if so, will you please produce the said note-books, and state the history of each one? 10762

A. I have found such note-books, and I produce them here.

Witness produces three books.

The first of these note-books, which is of octavo size, with paper cover and leather binding on the back, was the note-book which I used in 1858, while I was a student at Harvard University, in the laboratory of Prof. J. P. Cooke. This book was used by me at various times from that period up to August 23, 1872, which I believe, is the last entry. 10763

The said note-book is offered in evidence, and the same is marked "Defendant's Exhibit Dr. Adams' Note Book No. 1." 10764

The second note-book is a small pocket affair. I can identify the age of this book by an entry in it of July 15, 1862.

The same is offered in evidence and marked

10765

"Defendant's Exhibit Dr. Adams' Note Book No. 2."

The third note-book is a square octavo with full morocco binding. The earliest entry in this book is November 6, 1868. I had the book previous to that time, but the date mentioned is the first date in it.

The same is offered in evidence and marked
10766 "Defendant's Exhibit Dr. Adams' Note Book No. 3"

4 Q. Where did you find these note-books, and where have they been since you last used them?

A. The oldest of the three I found among packages of letters and receipted bills packed away in my drawers at Gloucester, Mass. The other two were packed in a case with a quantity of pamphlets of one description or another. The first mentioned book I have seen quite often, although I have not used it;
10767 but the other two I have not had occasion to use or see since 1883, when I moved my effects from the house I lived in at that time at Dorchester, Mass.

5 Q. Have the three books been in your possession ever since the original entries were made in them?

A. With the exception of short periods when they were in the possession of counsel in the nickel suits, they have. They have been in my possession altogether for twelve years at least.

6 Q. Please look at said note-book No. 1, third page
10768 from the end, and state what the sketch which appears thereon represents; when it was made; and who made it?

A. The sketch alluded to is a rough pencil drawing of a very early form of incandescent lamp. There is no date attached to this sketch, and I have no accurate idea of when it was made; but from its construction, I know it to be one form of what I used to call

10769

a miner's lamp. It represents an elongated glass globe or olive, with three tubulures, two of which are designed for platinum conductors to be sealed into the glass, and the larger or lower one to be used for the introduction of the carbon, and also for a socket for mounting. The carbon plate which is represented as between the metallic conductors is horizontal. There is a slight sketch of another form of carbon alongside of this other, which I recognize to be a very old form, and which was intended to be a reproduction in car- 10770
bon of the letter A.

7 Q. Who made the sketch?

A. It was made by me.

8 Q. State, if you know, what is the latest date at which this sketch might have been made?

A. Certainly not later than 1868, and probably earlier.

Sketch in question marked Dr. Adams' Sketch No. 1

10771

9 Q. Please look at the sketch in the upper left hand corner of the last page in the said book, and state when, and by whom that sketch was made, and what it represents.

A. The sketch was made by me, at a date which I cannot now state, not later, however, than 1869, I should say. There is a memorandum above it in pencil partially effaced, of which all that is left of it is the words "lamp" and "por tubes," of the signification
of which I do not now recollect anything. There are 10772
several sketches of Geissler tubes upon the same page and other apparatus, but the sketch in question is in the upper left hand corner. It represents another early form of incandescent lamp bulb, of which the dimensions are given in inches. It is similar to some that I had blown at the glass house in 1868.

10773

Sketch in question marked Dr. Adams' Sketch No. 2.

10 Q. Please look at the sketch which appears on the twentieth page from the beginning in your note book No. 2, and state when and by whom it was made, and what it represents?

A. This is similar to sketch No. 1, and represents substantially the same thing. It was also made by
10774 myself; it is without any date, but judging by the surrounding entries I should say it was made in 1867, or earlier.

Sketch marked Dr. Adams' Sketch No. 3.

11 Q. Please look at the sketch in the lower left hand corner nine pages further on in the same book and answer the same question as the last in regard to that.

10775 A. This is a sketch made by himself, without date, but from the surroundings made, I know, in 1867. It represents an early form that I used of an incandescent lamp and which I called a miner's lamp.

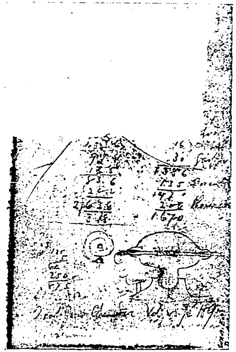
Sketch marked Dr. Adams' Sketch No. 4.

12 Q. What is the mode of sealing in the leading in wires in that sketch?

A. They are put in from the bottom of the bulb or globe, through two small tubulures, with a glass sleeve
10776 sealed into the tubulures a very common form in Geissler tubes.

13 Q. What is there about the entries surrounding that sketch which enables you to fix the date positively?

A. I took that book abroad with me in 1867. I had as companions at that time my brother, Mr. Aquila Adams, and a Mr. James Thatcher. I was in



From Ilmenau to Lichtenfels
take tickets for Lindau
boat from Lindau Rorschach
R.R. from Rorschach to
Chur. at Chur dilig.
to Colico from there boat
to Como R.R. to Genoa

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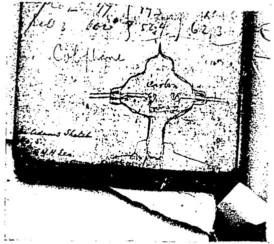

Carbon
Adams Sketch

the habit of making sketches of the lamp, and show- 10777
ing them to my companions; and that is one of them.
14 Q. Please look at the sketch on the twenty-
first page from the other end of the same book; and
state when and by whom it was made and what it re-
presents.
A. This sketch was made by me, in 1867, or about
that time. It represents an incandescent lamp simi-
lar in form to sketch No. 2, with the exception that
the platinum conductors have hooks on the ends, by 10778
which the carbon slip was suspended. It was got up
for the purpose of testing a carbon—which in this
lamp can be done without destroying the lamp.

Sketch marked Dr. Adams' Sketch No. 5.

15 Q. Please explain how this lamp was adapted
for testing different carbons without destroying the
lamp.
A. The carbons were dropped in from the upper
part. Then the upper part closed at the glass-blow- 10779
ers lamp. The upper part could then be cracked off
again, and the carbón removed without destroying the
platinums. The carbons were coppered on the end,
and to this coppering was soldered a slip of wire or
brass plate and bent over so as to fall into place in
the platinum hooks.
16 Q. Did you actually make this lamp?
A. Yes
17 Q. What was the object of coppering the ends
of the carbons? 10780
A. Simply to strengthen them, and make a better
contact, or allow the suspending wires to be fastened
to it.
18 Q. Please look at the sketch upon the first un-
numbered page of the note-book No. 3; state what it
represents, and who made it, and when?

10781

A. It represents a later form of the incandescent lamp than any that have yet been alluded to—unless it was the sketch No. 2. This has no date attached to it, but I recognize in a general way from the form of the apparatus that it must have been made about 1868.

Sketch marked Dr. Adams' Sketch No. 6.

19 Q. Please look at the sketches representing electric lamps and the memoranda relating thereto
10782 which appear upon the next two pages, numbered one and two, of said book; and please explain said sketches; state when they and the accompanying memoranda were made; and in whose handwriting the said memoranda are.

A. The first sketch on page one has the date November 11, 1868, above it. This date, however, does not especially refer to the lamp; but the sketch of the lamp must have been made about that time. The description and drawing are in my handwriting. The
10783 sketch is that of an electric lamp, of a form similar to Sketch No. 6, on the previous page. It gives the dimensions and more fully the details of the manufacture—in fact the details are quite full.

There is also on the same page a sketch of another method of mounting the carbon, which I do not think was ever executed, which was intended to represent an A.

On page two is a sketch of another method of mounting the same thing—an improvement on any-
10784 thing I had done up to that time. It is entitled "Upright Carbon Lamp finished June, '69." The details of manufacture are given to a considerable extent.

20 Q. Are all the entries on these two pages in your handwriting?

A. They are.

Sketches marked Dr. Adams' Sketch No. 7, and Dr. Adams' Sketch No. 8.

[Flowers ... Coste here]

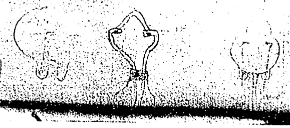
Electric Lamps

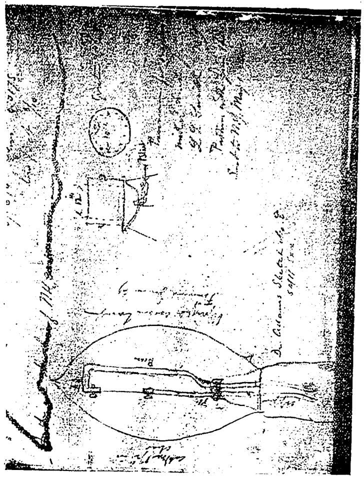
The carbon in this lamp is made from an arc regulator carbon sent me by Giffard with his regulator made in Paris and said to be O.P. carbon. It works splendidly with 12 Bunsen cells (6–2) and except that it is fragile is worth a hundred of Farmers medium lamps. This form is better than the old one but harder to make.

Platinum conductors [illegible]

Bulb blown at New Bedford.

Farmer No. 1 [illegible]





10785

21 Q. Were the entries of dates which appeared upon the said pages were all made by you at the time of said dates?

A. Substantially that; but the dates may not have been put down on the very day. The sketches all through this book of whatever nature are generally copies of sketches made upon blocks, made at the time of the experiments. The dates refer to the dates of the experiments.

22 Q. After looking at the entry "Upright Carbon 10786
Lamp finished June, '69." which appears on page two, are you able to testify positively that said lamp was finished on that date?

A. Yes.

23. Q. The entry which accompanies the electric lamp shown by Sketch No. 7 states, "it works spendidly with 12 Bunsen cells [6-2]." Please explain the meaning of the figures in the parenthesis?

A. They mean the method of coupling up the cells, in the nomenclature of that day, the quantity or intensity. 10787

24. Q. Were the lamps shown in these sketches also actually made and used by you in the years 1868 and 1869?

A. Yes, sir.

25 Q. Please look at the sketches on page 17 of the same book; explain them; state when and by whom they were make; and whether the accompanying memoranda upon the same page are all in your handwriting and made by you at the time.

A. The sketch on the left-hand side of the page 10788
represents an electric lamp made by me in the fall of 1873. It is similar in general construction to the lamp in Sketch No. 8, with a slight improvement, as I considered it at the time, in the shape of the metallic conductors on the inside of the lamp. The sketch and handwriting are mine, and I recognize the sketch as

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that of a lamp which I made at that period.

The sketch adjoining is one which I recognize as the sketch of an instrument made at that time. In fact there is a date on that—December, 1873—all in my handwriting. This is a sketch of an apparatus for determining the resistance of carbon plates, and by plate in this instance is meant the slip of carbon which I used in the incandescent lamp made by me at that time. The whole of this latter apparatus is not here
10790 sketched. As a matter of fact, the part that is sketched was enclosed in a glass globe. The metallic part of this particular apparatus was made by W. W. Graham & Co., machinists of Boston.

Sketches marked Dr. Adam's Sketch No. 9 and Dr. Adam's Sketch No. 10.

26 Q. Please state whether the apparatus herewith shown you, marked Deft's Exh. Dr. Adams' Lamp No.
10791 1, is a speciman of the testing apparatus you have just referred to, part of which is shown in Sketch No. 10.

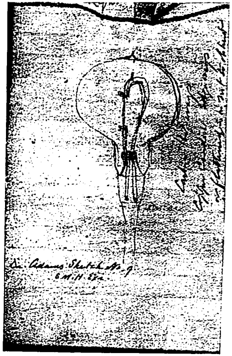
A. I recognize it as such. Yes, sir.

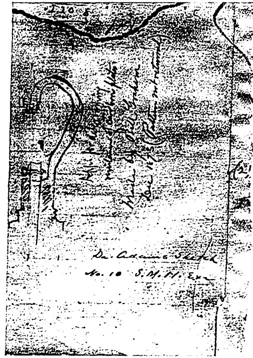
Adjourned for lunch.

Resumed.

27. Q. Do you remember using the specimen lamp just shown you at the old establishment of Smith, Finney & Smith, in 25th St., in this city; and if yes,
10792 state whether you burned any other lamp there at the same time, and what took place there on that occasion?

A. I remember using the apparatus in question as a lamp there in an experiment to determine the effects of various gases on carbon when raised to incandescence. This particular apparatus had a slip of carbon fastened between the two poles, and the globe in this




Dr. Adams Sketch
No. 10 S.M.H. Ex

instance was filled by displacement with street-gas. 10793
The globe, after the current was put on, was very soon completely blackened on the inside, so as to practically obscure the light. I left the whole apparatus at the shop, and have not seen it since until recently, but I judge from its appearance that somebody has partially cleaned the apparatus on the inside, as it was covered with soot when I left it.

The shop was not then carried on by Smith,
Finney & Smith, but by the New York Nickel Plating 10794
Co., and the experiment was in the very last of 1873, or early in 1874. I had at that time a lamp similar to the one shown in Sketch No. 9, which was run by the magnetio machine, possibly an hour—possibly less, but certainly half an hour—and which did give a very brilliant light with that machine.

This latter lamp had a vacuum, but the vacuum was made through the upper end of the lamp and not through the lower end as in Sketch No. 8. This
lamp, that I refer to, as Sketch No. 9, was intended to 10795
be mounted in an upright position. It was not so mounted at that time—that is, on a wooden support, as it was the intention that it should be. The carbon slip was made from a piece of arc-carbon, dressed down to a sufficient degree of thinness, and the only difference between this lamp and the one noted as Sketch No. 8, was in the curved shape of the internal conductor, which gave it a little more elegant appearance, and in the fact that part of the conducting surface was flattened. By this means there was
less obstruction to the light. 10796

28 Q. Why was the metal support to which the carbon slip to be tested was attached in said Exhibit Adams' Lamp No. 1 made so heavy?

A. The apparatus was originally made and used for the purpose of determining the resistance of carbon slips, and was made heavy so that the resistance of

10797 the metallic parts of the lamp could be neglected.

29 Q. Did the New York Nickel Plating Co. immediately succeed Smith, Finney & Smith, without other change than that of the proprietorship?

A. Yes, sir.

30 Q. Do you know Mr. Alonzo C. Brackett, who was formerly in the employ of Smith, Finney & Smith, and continued in the employ of the New York Nickel Co.?

10798 A. I remember him very well. He was employed by both concerns in packing or papering the articles after they were plated.

31 Q. Was he about the establishment at the time you burned the lamp there?

A. Personally I cannot say whether he was or not. I do not recollect seeing him at that time. He might have been there and I not have seen him.

32 Q. Do you remember anybody who was present when the lamp was burned on the occasion referred
10799 to, beside yourself?

A. I recollect that Mr. Henry A. Tweed was about the place. He was the treasurer of the concern. I also know that my brother Aquila Adams was there at the same time.

33 Q. Did you ever run any of these lamps at Julius Smith's establishment or place on Sudbury Street, in Boston?

A. I have a faint recollection of carrying a lamp there when Mr. Smith was constructing a magneto for a concern of which I was president at the time. I re-
10800 collect it perhaps more from the fact that I wanted to test the lamp on a magneto, which I never before had an opportunity to do, as magneto machines were a great rarity in this country then—in fact I believe there were only three.

34 Q. Were the places where you ran these lamps on the magnetos in New York and Boston kept secret,

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or were they open to such persons as had business at those establishments?

A. So far as the early lamps were concerned—those, I mean, that were made prior to 1869—my laboratory was practically a closed room to the public. I was making Geissler tubes at the time, and had been for several years, and the public were excluded for the reason that I did not care to show my method of making those tubes. I had very few intimate acquaint-
ances, those that I had occasionly came there. 10802

As regards the other places there was no concealment necessary or intended. The lamps were tried, so far as any intention was concerned, in public.

35 Q. You have mentioned in one of your preceding answers, coppering the ends of one of the carbon conductors of your lamp; please state whether or not in making your lamps you did copper the carbons, and, if so, how frequently, where, and for what purpose?

A. The last operation in the preparation of the 10803
carbons was the depositing of silver or copper upon them, more frequently silver than copper. This was done invariably, with every carbon that I ever put into a lamp. Only the ends of the carbon had metal deposited upon them—that part which was intended to come into contact with the metallic conductors, and this coppering or silvering was intended for the purpose of strengthening the carbon at the ends, and also of improving the contact.

36 Q Were the ends of the same size as the rest of
the carbon? 10804

A. No, sir; the ends were considerably thicker—four or five times as thick as the middle of the carbon.

37 Q. Why was this?

A. Principally to enable it to be better handled, and to resist the crushing action of the clamp.

38 Q. In your affidavit you mention making "per-

10805 fect vacuum tubes." Was the vacuum in the lamps which you have made, and concerning which you have testified, and which are referred to in your affidavit, as high a vacuum as that which you produced in your said "perfect vacuum tubes;" I, of course exclude from the question the testing apparatus, Adams Lamp No. 1.

A. Yes, sir.

39 Q. You mention in your affidavit the Bunsen
1080 method of making carbons; will you please explain that method a little more fully?

A. The method was devised and published by Prof. Bunsen of Heidelberg, the inventor of the so-called Bunsen Battery, the construction of which called for a considerable mass of carbon, and the process is substantially as follows:

Gas-retort or other forms of carbon are pulverized and mixed with lampblack, and the two powders are made into a stiff paste with a concentrated solution of
10807 sugar in water. I think there are other carbonaceous matters mentioned such as starch or molasses, which may be used; the pasty mass is then pressed into molds, the mold being of whatever form the article is required to be; the closed molds, which are generally of iron, are then baked at a red-heat in a furnace or oven of a suitable description; after cooling they are dipped in a strong solution of sugar in water, and again raised to a high temperature--a white-heat, if possible; by repeating this process of dipping and heat-
10808 ing a very dense and tough carbon is produced; the process is very old—I don't know how old—probably forty years.

40 Q. Was the sketch annexed to your affidavit made before you found the note-books that have been put in evidence to-day.

A. It was.

41 Q. Is M. Gaiffe, mentioned in your affidavit.

still living? 10809

A. He is dead.

42 Q. Were these lamps referred to in your affidavit and the rest of your testimony actually run and burned by you sufficiently to enable you to ascertain their practical character; and how were they in respect to their being practical, successful lamps for illuminating purposes and actual use?

A. I ran them sufficiently to determine in my own mind that they were thoroughly practical. Some, in 10810
fact all, of the earlier lamps—from 1867 up to 1869—were, so far as the shape of the lamps and the method of introducing the carbon, and also the metallic conductors, more or less of a crude character. They were not the less practical on that account, however; and by that, I mean, as to the perfection of the seal and the duration of the vacuum. After I got the proper material to make them of, I never knew one to leak.

The changes in the form of the lamp were brought about by the experience of making them, and related
really to the art of glass-blowing, rather than anything 10811
else.

43 Q. To what degree of incandescence did you raise the carbons when you ran them?

A. I had no means of measuring at that time, and it would be largely guess-work. But they were raised to a temperature similar to that of the lamp I am now looking at, which appears to be an ordinary 16-candle power incandescent lamp. There were occasions when I think it was raised to a higher temperature than this
appears to be: but still it is largely a matter of guess- 10812
work.

44 Q. How did the light given compare in brilliancy and power with the light of the ordinary incandescent lamp to which you have referred in your last answer?

A. There was no trouble in producing that amount

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of incandescence and light, as I recollect it, or considerably more with some of the lamps.

45 Q. In applying the Bunsen process to making your carbons, as you have described that process in answer to 39 Q. did the carbons receive their shape before final carbonization?

A. Yes. The last operation of carbonization was when the carbon had been worked down to size. At that point in their manufacture I heated them, pro-
10814 bably to the melting point of platinum, certainly to that of wrought iron.

46 Q. How were these carbons, as to durability. I mean the ones that you actually made and used in your lamps?

A. Entirely durable, so far as being burned up was concerned, or being destroyed by the current.

47 Q. What obstacles, if any, at the time you made these lamps, existed as to manufacturing them on a large scale and putting them on the market as a com-
10815 mercial article?

A. So far as the lamps themselves were concerned, there was no obstacle that I know of. The trouble was in finding some source of electricity by which the lamp could be run economically. I was somewhat familiar with the experiments during those years of Moses G. Farmer, the noted electrician of those days. That is, I knew substantially what he had done in the line of incandescent lighting. His latest effort in that direction required the use of a slip or bar of iridium for the incandescent material, he having al-
10816 ready tried platinum and discarded it. I was also knowing to the fact that he was aware that there was no source of electricity which could be economically used for that purpose, and that he was experimenting with what was called a thermo-electric battery, which turned out to be a complete failure so far as efficiency was concerned. The machine that to-day is called a

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dynamo was not then in existence. The so-called electro-magnetic machines were known, but their efficiency, as measured by the cost of running them, was not sensibly greater than that of the ordinary Bunsen battery. I had and used at that time a magneto-electric machine made by Mr. Farmer himself, which I borrowed from the party for whom he made it. The fact that I have stated as to the lack of a proper source of electricity was a complete block to any method whatever of commercial lighting by elec- 10818
tricity, whether arc or incandescent, and particularly of the latter.

48 Q. Did you yourself at that time have the time or money to devote to an attempt to invent and develop a system of supplying electric energy cheaply enough to make it practicable to run incandescent lamps on a commercial scale?

A. At that period of my life I was earning my daily bread by my daily labor, and I had neither the means nor the opportunities of getting means which would be necessary to develop the art of lighting by elec- 10819
tricity.

49 Q. Please state a little more fully than you have mentioned in your affidavit what have been your necessary labors and the necessary demands upon your time in connection with the nickel-plating litigation—stating also when that litigation began and when it was finally closed.

A. The litigation commenced in the summer of 1869. I might say it continued without any interruption at all, until 1888, when I settled the last suit. 10820
The subject of litigation related entirely to inventions made by myself, and was based upon patents taken out by myself. The patents were represented by a company called the United Nickel Co. The stock of this corporation was controlled and held by very few people—three-quarters of it by less than a dozen, and

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of those controlling stockholders there was no one except myself who was not either a man of independent means, or whose circumstances did not make him entirely independent of any income from the nickel business. And there was no one except myself who did or expected to do any labor in regard to the business of the company, or in defending its interests before the courts. The consequence of this was that the whole business, with the exception of actually hand-
10822 ling the money, which was done by the Treasurer, fell upon me. We carried on very extensive litigation in ten or twelve different states of the Union, and brought hundreds of suits—quite a number of them to final hearing. We had, all told, first and last over a thousand licensees, most of whom were in a dissatisfied condition all the time. I gave a large part of the expert testimony in these cases, looked up the witnesses, and, generally speaking, did the drudgery of the cases in court. Take it all together, I had
10823 as much as one man could possibly attend to in this one matter alone.

Adjourned until Oct. 17, 1890, at 11 A. M.

New York, Oct. 17th, 1890.

Met pursuant to adjournment at the office of Kerr & Curtis.

10824 Present: Counsel as before.

Examination of Dr. Adams continued by Mr. Wetmore.

50 Q. Referring to the statement in your affidavit and in your answer to 12 Q. as to the manner in which Geissler tubes were constructed, exhausted and

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sealed, will you not explain a little more in detail than you have done, what that method was as practised in the manufacture of "perfect vacuum tubes" and your electric lamps?

A. The so-called Geissler tubes are apparatus made of glass for the purpose of showing the effect of high tension electricity on gases. For this purpose after the introduction of the particular gas which it is desired to experiment with a very high vacuum is made. 10826

In order to preserve this vacuum, platinum wires are sealed into the glass by fusion. These tubes are made in all sorts of shapes and forms that the fancy of the glass-blower can suggest. As an example of how a tube is constructed, I will take one of the simplest forms; that of a straight tube, say an inch and a half in diameter and two feet long A small aperture is made in one end of the tube into which is introduced the platinum with its sleeve (a sleeve is a piece of glass tubing, perhaps an eighth of an inch in 10827
diameter, and from a half inch to an inch in length, which has previously been fused upon and surrounds the platinum); the object of this sleeve is only to make a longer seal than would be possible if the platinum was introduced directly into the glass. The other end is treated in a similar way, but as the glass has to be blown out while the platinum is being fused in, a small tubulet is made on the end which is soldered a small piece of tubing six or eight inches long and this answers the double purpose of complet-
ing the joint about the platinum and of exhausting 10828
the air. We now have a straight tube with platinum conductors hermetically sealed into each end, the platinum conductors projecting into the tube at each end. In ordinary practice there is, in addition to this a piece of aluminum wire roughly soldered to the interior extremity of the platinum conductor. The

1082 tube is now attached to an air pump. An ordinary mechanical piston air-pump is not suitable for this purpose, and before these tubes could be made and sold as commercial articles it would be necessary to construct a different kind of air pump. One of the ordinary pumps in use is called the Geissler mercury pump; there are other pumps, but for the purpose of this answer they are not material. The principal effect which is sought to be produced by these
10830 tubes is what is called stratification and this in general terms means that when the tube is properly constructed and a current of electricity from a Ruhmkorff coil is passing through it, the illuminated gas appears to be cut into sections or stratifications. The color of these stratifications depends upon the kind of gas which has been introduced into the tube previously. The gases which give the finest stratification under the influence of the electric current are nitrogen, carbonic acid and hydrogen, the colors of which are
10831 crimson, green and violet respectively. In order to produce these stratifications and the actual colors due to the gases they must be practically free from admixture with other gases, and also the vapor of water. It happens to be that the metallic conductors in the interior of the tube hold occluded gases of different kinds, and the interior surface of the glass has condensed upon it gases of different kinds. The mere producing of high vacuum will not remove these occluded or condensed gases except with extreme slowness; they would eventually become mixed with the
10832 gases in the tube; but they are readily driven out by heat. After the vacuum has been produced a number of times, dry air being introduced each time in order to dry the tube out, the tube is heated as hot as the glass will bear, by any suitable means (in my own practice by a Bunsen gas burner.) This drives out the occluded or condensed gases which are taken away by the process of exhaustion.

The tube is now ready to have introduced into it the particular gas required. The pump is worked, the Ruhmkorff coil is attached to the conductors, a current of electricity is now continuously passed through the tube until the desired effect is produced. 10833

As a rule this operation of heating and passing the current of electricity through it has to be done several times, particularly in large tubes. A vacuum represented by one milimetre of mercury is about what is necessary to produce the best effect, the normal press- 10834
ure of the atmosphere being 760 milimetres. At that pressure all gases appear to be ready conductors of high-tension electricity such as is exhibited in the Ruhmkorff coil, or any apparatus which will furnish a spark in the air. If the pressure is lowered, however, much below one millimetre of mercury, the conductivity of the gases rapidly decreases until a point is reached readily by the mercury air-pump at which electricity ceases to pass even when the internal conductors are placed as near together as mechanically it is practical to place them. 10835

It was to demonstrate this last phenomenon that the so-called "perfect vacuum tubes" were made, and they represent the highest degree of vacuum which is known or can be produced by any method. The incandescent lamp that I made, as a matter of fact, was a Geissler tube, constructed in precisely the same manner as a "perfect vacuum tube," exhausted on the pump in the same way and tested by a current of electricity from a battery while on the pump in process of construction in the same way; the difference between 10836
the Geissler tube, and the lamp being simply this, that in the lamp the internal conducting wires were connected by a slip of carbon and the electricity furnished was not from a Ruhmhorff coil but an ordinary battery.

10837 I have forgotten to state in my description that when then the apparatus, whether Geissler tube or lamp, produced the proper result, it was detached from the pump by fusion.

51 Q. In making your electric lamp did you pass the current through the carbon conductor while it was on the pump during the process of exhausting the tube, and, if so, how frequently during the process and for what purpose?

10838 A. The current from the battery was passed through the carbon while the lamp was being constructed, just exactly as it was done in the case of a Geissler tube, the only difference being, that in one case, that is of the lamp, the electricity was furnished by the battery direct and in the other by a Ruhmkorff coil; the purpose of heating the carbon was for driving off the occluded gases, and the temperature produced was in the neighborhood of a red heat.

52 Q. You state in your affidavit that you made
10839 your first lamps in the years, 1865, 1866; do your note-books, which you subsequently found refresh your memory as to the date in question, and if so, do you wish to correct your first statement in any respect?

A. After seeing various memoranda in one of the note-books presented in this case, I have come to the conclusion that I could not have made any perfect lamps previous to 1867; my impression was when I made the affidavit that it was earlier.

53 Q. In your answer to 21 Q. you speak of having
10840 frequently made your first sketches upon "blocks," please state what you mean by "blocks?"

A. I mean what are called here paper pads, that is leaves of blank paper pasted together that can be detached readily one at a time.

54 Q. Please look at the lamp herewith shown you, and state whether it has just been made under your supervision and represents with substantial correctness one of the forms of lamps which you made and which are illustrated in your sketches?

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A. I can hardly say it has been made under my supervision; it was made by a glass blower under a general direction from me, and, with the exception that it is of inferior quality as regards glass-blowing, represents substantially one form of lamp that I made between 1867 and 1869. In shape it does not precisely follow the sketch furnished, which is due to the fact that the glass blower had not the shape of the bulb to work with, and there was no time to get other. As a matter of fact he had to use what material he found at 10842
hand. The carbon in it, is worked down from a piece of ordinary arc carbon without any further preparation, but has not been manufactured in the manner I used at that time, and is not as I would have made it, if I had had sufficient notice that a lamp of this kind was wanted. Without knowing it absolutely to be a fact, the glass, in my judgment is not of a proper kind to be used with platinum of this diameter; however, it represents in a rough way, the lamp made by me in 1867 and 1868. The lamp has been tested and 10843
measured: I did not work the instruments of measurement myself, but I saw them used. The measurements are fourteen volts, eleven and one-half amperes and forty candle power. This corresponds to a resistance of about one and two-tenths ohms.

Lamp referred to offered in evidence and marked "Model of Dr. Adams' Lamp of 1868."

55 Q. You say you did not make your lamps in that way, do you mean that the lamps that you made were 10844
better or worse in point of perfection and workmanship?

A. I mean that the lamps were better in point of workmanship; by that I refer to the glass portion of the lamp. The person who made this lamp, was not accustomed evidently to that sort of work.

10845

56 Q. Please look at the lamp herewith shown you and state whether that represents with substantial accuracy another form of lamp made by you and already referred to in your testimony and sketch book?

A. Yes, it does; the lamp I completed in June, 1869.

Lamp offered in evidence and marked "Model of Dr. Adams' Lamp of 1869."

10846 57 Q. You have not yet seen yourself, have you, the measurements taken upon running this lamp?

A. No. I have not.

58 Q. Referring to exhibit "Lamp of 1868," you say that the carbon in it has not been manufactured in the manner you used at *that* time. What do you mean by *that*?

A. My method of preparing the carbon was to file or scrape it as thin as I could or dared to, then to soak it in sugar and heat it in a crucible surrounded
10847 by any fine carbonaceous powder, lamp black for instance, to a temperature as high as I could produce in Deville's gas furnace.

59 Q. Is the carbon of the exhibit better or worse than the carbon you used to make?

A. The external appearance is all right, but I doubt if it would stand as well as those I made; still it is a pretty good attempt for a first one, for I assume that the man who made it never made one before.

I wish to add to answer to 56 Q, that I notice that the carbon in the exhibit is placed in reverse position
10848 to that in which I had it. It is not material, but the carbon is faced the other way from that of the lamps I made.

60 Q. Please state whether or not the following description taken from Sprague's Electricity of 1875, Section 144, describes the Bunsen method to which you have referred and which you say you practiced in making the carbon conductors for your lamps:

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"144. Artificial Carbons. Plates or blocks may be built up from powered graphite mixed up with coal tar or strong rice paste, into a stiff dough, which should be dried, heated, then packed in powered carbon in a closed vessel and heated to clear red for some time. When cool they should be soaked in strong syrup of sugar or treacle, again dried and treated as before: this process must be repeated until the carbon
is perfectly dense and strong. In this way are 10850
made cylindrical vessels, left somewhat porous to hold the acid and act the twofold parts of porous jar and negative plate; many of the plates and blocks in batteries of French make are thus made, and work fairly well. but under some chemical reagents they break up.

Battery plates, &c., are also made of plumbago crucible material, but this soon disintegrates. Faure's Battery is made of this material
in exactly the form of a ginger-beer bottle, this 10851
contains the acid under a pressure caused by the gases given off, which are retained by means of a graphite stopper ground in, which also serves for the connection of the cell, being fitted with a binding screw."

A. Yes, it is.

61 Q. In the memorandum on page 1 of your notebook No. 3, you speak of "C. P." carbon, please state what that means?

A. It is the contraction used by chemists for the 10852
words "chemically pure"

Direct examination closed.

Adjourned for luncheon.

10853

RESUMED.

Cross-examination by MR. LOWREY:

62 x-Q. Where were the two lamps testified to by you this morning in answers to questions 54 to 59 made?

A. At the Westinghouse factory, nearly at the foot of 23rd Street, New York City.

63 x-Q. Were they made under instructions, direct-
10854 ions and drawings furnished by you, and if so, when were these finished?

A. The lamp first shown was already begun, I think, when I arrived in the city, and was made from a drawing which I furnished with the affidavit and before I had seen my note book.

64 x-Q. How many lamps did you make corresponding substantially to either of these during the period you have named, 1867 to 1869, I think you say?

A. I cannot say as a matter of recollection how
10855 many I did make, but I broke a good many, I recollect that very well, and of course if I broke them I had to make them, and there was a difficulty in their construction which existed at that time, and that was the introduction of platinums of large cross-section into the glass. They would crack and I had to overcome that difficulty, and every time they cracked it destroyed a lamp. I also had some difficulty in the preparation of the carbon, although after a while that ceased to be a difficulty; that is, I mean in reducing them to a sufficient degree of thinness without fracture,
1085 but I cannot really say how many lamps, it is too far off.

65 x-Q. Considering those which you broke in process of construction, and those which you retained long enough to exhibit the light in them, about what was the proportion, do you think, of those which came to practical completeness, and those which failed.

10857

A. That I cannot say. The fact of the matter is that after I once obtain the kind of glass I wanted, there was no difficulty in making the lamp; and the lamps that were made after that period—and that period can be tolerably definitely stated by my note-books—I made no failures in lamps, and if the lamps were broken after that, it was by accidental breakage by being roughly handled; the form of these lamps developed from the very crude ones in 1867 in my note-book, to the better form of 1869. 10858

66 x Q. Have you any of the lamps left, or do you know of any in existence which you made at that time?

A. There are none in existence that I know of. The nearest approach to it is an elongated globe which I have found within a week, which has no mounting, however, of carbon, but which I recollect from the form and appearance, was a lamp which was constructed like the second lamp that is here shown; but it was broken and all that was left of it is the bare 10859
shell.

67 x Q. That is, you mean merely the glass part?

A. Yes, the glass part—well, even the glass is broken—the end of the glass.

68 x Q. It has no mounting then, whatever?

A. No mounting, but I recognize it for a particular reason, that there was fused into it some ruby glass on both ends.

69 x-Q. Was that a durable and operative lamp?

A. Yes, sir.

70 x-Q. Do you remember how long that lasted? 10860

A. Well, I had that lamp probably a year or more.

71 x-Q. And under a current—how much at a time?

A. That particular lamp?

72 x-Q. Yes.

A. I do not know. I cannot recollect how long

10861 that run. They were tested from time to time in this way; I was making Geissler tubes as a matter of business; I was also using batteries for plating purposes. I had at all times batteries set up in my laboratory. Bunsen cells of large size—in fact, the largest size that is made, that I know of. I would occasionally try a lamp without any particular purpose except to see if the platinum was holding the vacuum. I had no idea at that time of having done anything of any
10862 special merit, as I thought the introduction of a piece of carbon into a globe to a person who was in the habit of making Geissler tubes was not much of a trick; but I was interested in the fact as to whether or not the big platinum that I put in the glass would hold, because I have always considered—did then, and do now—that I made an invention there which was a useful one. That was my interest in the lamp, and that was about all the interest I had in it.

73 x-Q. Do I understand you that you considered
10863 that to unite platinum and glass for the purpose of conducting a current into a vacuum space, was a novelty at that time?

A. Not at all.

74 x-Q. What was it that you considered meritorious by way of uniting these two in those functions?

A. Introducing platinum wires of relatively large cross-section was the novelty.

75 x Q. Now you have said that you tried these lamps, in what I understand you was a casual way, from time to time, with only the purpose of seeing
10864 whether the platinum stood.

Did you ever note the resistance, or did you make any other measurements of current or resistance in conductors?

A. I am quite sure that I did, but I have no record of anything of that kind, although I haven't any doubt that I did do so. As a matter of fact, I kept a

tolerably good account of my experiments on paper 10865
pads, and I had them, or they were in existence, until 1872, when a great many of them were destroyed by the effects of a fire in the building.

76 x Q. Did you sometimes find upon these testings that the platinum connections were broken between the glass and the conducting wire?

A. Many times from 1865 to 1867.

77 x Q. Now in respect to the test of a lamp that you have mentioned in your affidavit which you think 10866
lasted for some two hundred hours, I believe, it is said; how was that test made in respect to the other experiments?

A. My recollection of that lamp is that it was the lamp that I made in the spring or early winter of 1868 or 1869. I have no means of fixing it, however, but from things that happened about that time, I infer that to be the lamp that I referred to in my affidavit, and the lamp, also, which I took abroad in 1869; and my impression now is that that was the identical 10867
lamp.

78 x Q. How do you get at the aggregate time of two hundred hours distributed over two years, rather than four hundred or one hundred?

A. I might have said four hundred, but it would have been guesswork, and it is guesswork to say two hundred. I have no accurate idea of how long it did run in hours, but I know this that that particular lamp that I referred to was run a great many times for a short period.

79 x-Q. And on the whole, it was as well to say 10868
two hundred as any other time—a mere guess?

A. There is no doubt of it; it is a guess at this time. I have no means of knowing accurately how long.

80 x-Q. Was it your custom to test lamps when completed, for the resistance?

10869

A. No, sir.

81 x-Q. Why didn't you test them for resistance?

A. One reason was that the apparatus for testing resistances at that time was not the apparatus of to-day by any means; it required special apparatus to be set up in shape of galvonometers, Wheatstone bridge, etc., which I did not use except rarely. As a matter of fact, also, there was no accurate means of measurement within my reach, although they did furnish
10870 what was called an ohm at that time something in the nature of an ohm, but it was anything but an ohm. It was a very imperfect ohm, and the instruments were imperfect to which I had access. That was one reason; another reason was that I was not interested in that direction. I was not proposing to get up a system of lighting, not at all. I was simply making a lamp, what I considered the best form of lamp, and the best material to use, and the best shape to put it in.

10871 83 x-Q. You say in answer to 49 Q. that you made lamps which were "entirely durable." Those words "entirely durable" are of course, construable with reference to the nature of the thing, and the circumstances under which it was used; but I would ask you to be a little more specific, and tell us what experiences you base the opinion upon that you made an "entirely durable" lamp, and what you mean by "entirely durable." Under what circumstances would it be "entirely durable"?

10872 A. I considered the lamp in which the platinum—that is to say, in which the vacuum remained as perfect, apparently, as when it was made, a lamp in which the carbons did not be deteriorated sensibly so far as could be seen by the eye, whether ignited or not, and a lamp which could be left to itself for a period of months at a time, and then tried again; I considered that a durable lamp.

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83 x-Q. Then you did not use the term with reference to continuous use in lighting, but to a continued existence, broken in upon by occasional lightings?

A. Exactly.

84 x-Q. You have spoken about "working down" the carbons, in answer to 45 Q., and perhaps you have explained in a late answer all that I want, but I will ask you to state more specifically what you mean by working down, beginning with the character of the material on which you worked. Was it carbon 10874
before you began working it down?

A. I started the making of the carbon by carbonizing at a red heat a pasty mixture of carbon, etc., as I have stated somewhere else. This carbon was made in small moulds, and was undoubtedly thoroughly carbonized in the furnace in the first place. It was dipped in a strong solution of sugar and carbonized several times. The method, then, of completing the carbon, or working it down as I have expressed it somewhere else, was by sawing of sections from the 10875
plate, as I recollect about a thirty-second of an inch thick, redipping and reburning those. They were then worked down with a file and scraper to about the thinness that I dared to go; sometimes as thin as [illegible]ths of an inch. This was dipped again in sugar and put in a crucible, a luted crucible, and heated up to a temperature, certainly is high as melting nickel.

85 x-Q. Please give the dimensions, now, of the plate as it first came from the carbonizing furnace before you began to work it down? 10876

A. My recollection is that it was about three inches—two or three inches long, two inches wide, and in the neighborhood of a quarter of an inch thick; probably a little thicker than that—not much.

86 x-Q. And you worked that down into pieces—give the same dimensions of those, now, please?

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A. That was worked down into pieces varying from probably three-quarters of an inch to one and a half inches in length; I should say some longer, sometimes, than that. The width, about one-quarter of an inch—from one-eighth to one-quarter of an inch. The intention was to have them about one-quarter of an inch, but in working them down, they would sometimes chip on the edges, so they would have to be re-dressed, and consequently reduce their cross-section
10878 in that direction; the thickness, from $1/_{100}$th of an inch to half of that thickness.

87 x-Q. When did you cease to occupy yourself entirely with this lamp subject?

A. In the spring or early summer of 1869.

88 x-Q. Have you seen any of the lamps since then —since that time?

A. Yes, oh yes; I have seen—I had one of the lamps at least, in my possession as late as 1872.

89 x Q. You were said to have had one at the work-
10879 shop of Smith, Finney & Smith. Do you know what became of that?

A. That was not a lamp I made at the period you first referred to.

90 x-Q. At a later period?

A. That was made at a later period. The lamp that I had at the New York Nickel Plating Company's works in 25th Street was made at about that period at which it was used.

91 x-Q. It was a mere illustration, however, of the work which you completed in the spring of 1869?
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A. Exactly; it had some changes that I thought were improvements, but otherwise it was just like the rest of them—the others.

92 x Q. Did you cease to prosecute your experiments in that way for want of means?

A. I had means enough after I sold the nickel patent in the spring of 1869, but the sale of those patents was

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made upon the understanding that I should retain an active interest and remain entirely in the employment of the parties who bought; as a matter of fact, I did do so, and I had no time to do anything else, even if I had cared to do anything about electric lighting, which I did not; there was no money in it then.

93 x-Q. You have taken out an electric light patent, I find; have you taken out more than one?

A. No, sir.

94 x-Q. Look at the printed copy which I hand you, 10882
of Patent No 282,030, of July 31st, 1883, for an Incandescent Lamp, and say whether you are the inventor of that lamp?

A. Whatever this is, it is not a correct representation of the thing itself; neither was it intended for a lamp; the apparatus that I am looking at, Figure 3, was got up to demonstrate to Mr. Ed. Dickerson, the younger, and to Prof. Morton, that I could introduce very large platinum wires into a glass globe and have them undergo a considerable amount of abuse without 10883
destroying the seal; the apparatus Figure 3, is the apparatus that was used then, and was not intended for a lamp, but was intended to show the incandescence, however.

95 x-Q. In what relation were Mr. Dickerson and Prof. Morton to you that you should wish to show them anything on this subject?

A. I had no relations with them—with either of the parties that I have named, of a business kind, or any other, but I had mentioned previously the fact, that I 10884
considered to be a fact, that Mr. Edison had not got the proper form of lamp, and that I had a better one.

96 x-Q. This you said to them while discussing the subject of incandescent electric lighting prior to the date of this patent?

A. Yes, a good while prior.

97 x-Q. As far back as 1778 or 1879?

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A. As far back as 1879, certainly. It was at the time that some person with whom—I had no means of knowing who—but I assume belong to the Edison organization, were publishing articles in the newspapers. I cannot say just what date that was, but it must have been along there—whatever it was, I cannot recollect precisely, but it was about that time.

98 x-Q. The descriptions you speak of were of Mr. Edison's incandescent lamp which was given to the
10886 public, as you understand it—practically this lamp which is in use now?

A. The newspaper accounts covered the platinum lamp, and the carbon lamp, yes, sir.

99 x-Q. The Edison platinum and Edison carbon lamps?

A. Exactly.

100 x-Q. Did you at that time or at any time, mention to Mr. Dickerson or Prof. Morton that you had yourself made an incandescent lamp, covering the
10887 same elements as the Edison lamp then under discussion?

A. I told the elder Dickerson so, and I am very sure I did the younger Dickerson.

101 x-Q. And Professor Morton?

A. Likewise.

Complainant's counsel offers in evidence, the patent to which the witness's attention has been called, No. 282,030, granted July 31,
10888 1883, to the witness, for incandescent electric lamp, and the same is marked "Complainant's Exhibit, Adams' Lamp Patent."

Re-direct examination by Mr. Wetmore.

102 r-d Q. Did you have any trouble with breakage in your lamps after you got the proper glass for the

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large size pplatinum which I understand you to say was in 1867?

A. No, sir.

103 r-d Q. And speaking in relation to the lamp you took with you to Paris, and which you state in your affidavit you ran for at least 200 hours in all, from what recollection and facts did you make that estimate.

A. The Bunsen batteries I used in my laboratory were coupled in series of four as a rule, sometimes six 10890
I had always more than one set of batteries set up and ready to be used. The batteries used to require replenishing about once a fortnight. All this I recollect well enough, and a circumstance upon which I fix to determine the times and the length of time which I ran the lamp is the fact that when I set up a fresh battery I used to try the effect on the lamp while the battery was still fresh, and I know that I did this a good many times, just how many I cannot say.

104 r-d Q. As I understand your statement about the 10891
Bunsen method which you practiced in making carbons, the material was brought partially to shape and carbonized, and then brought more nearly to shape and carbonized again; being brought to its final shape before final carbonization. Is that correct?

A. It is correct.

105 r-d Q. Where is the fragment of the glass bulb having the ruby glass which you referred to in your cross-examination?

A. It is in Cambridgeport in one of the cases in which was packed up some of my laboratory material 10892
when I removed from Dorchester in 1883.

106 r-d Q. Will you produce the fragment in order that we may put it in evidence?

A. Yes, I will try to.

Isaac Adams

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Complainant's counsel offers in evidence the affidavit of Mr. Leonard E. Curtis, one of defendant's solicitors, verified October 6, 1890, and forming part of the moving papers on the motion made on behalf of the defendant to amend its answer so as to set up a prior use by Dr. Adams.. It is stipulated that the following is a correct copy of such affidavit:

10894

STATE OF NEW YORK, }
City and County of New York. } ss.:

"LEONARD E. CURTIS, being duly sworn, deposes and says.

I am one of the counsel for the defendant in the above entitled suit. For the past ten years I have
10895 had general charge of the patent matters and patent litigation of the defendant, and since the commencement of this suit I have had general charge of the proceedings on behalf of the defendant herein. I had particular charge of collecting information in regard to prior uses and prior patents and publications for the preparation of the answer. My instructions from the defendant were to spare no trouble or expense in collecting such information, and in pursuance of these instructions I had exhaustive searches made in the literature of the subject and investigated with
10896 great care all information I could get in regard to prior uses of incandescent lamps. In the course of these inquiries I consulted with, or had others associated with me consult with, all the persons I could find who were engaged in electric lighting in this country prior to 1880, or who were engaged in any other line of

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business in which, so far as I could ascertain, electric lamps would be likely to be made.

The suit was deemed a very important one, and these various investigations were for this reason made unusually thorough, having involved an expense to the defendant corporation of several thousand dollars. At every stage of the investigation I advised fully with my associates, Mr. Wetmore, Mr. Duncan and Mr. Thurston, and also with the scientific experts, Dr.
Morton, Prof. Cross and others, who had been retained 10898
by the Company; and every suggestion made by any of these gentlemen that held out a promise of additional information of any value was adopted and followed up by a search along the lines thus indicated. I fully believed at the time that the inquiries then made on behalf of the defendant were exhaustive of the subject.

I had no knowledge, nor did I ever receive any intimation until shortly before the middle of last month, that Dr. Isaac Adams, whose affidavit is hereto an-
nexed, had made any electric lamps or had had any- 10899
thing to do with electric lighting prior to 1880. The matter was then brought to my attention in the following manner: The Edison Company, the complainant herein, brought suits some time since against the Perkins Electric Lamp Company upon certain of its patents relating to methods of constructing the glass bulbs of incandescent lamps, and I was retained as one of the counsel for the defendant in those suits, Mr. E. D. Robbins, of Hartford, having direct
charge of the defence. I had been informed that 10900
Dr. Adams had made Geissler tubes at an early date and I advised Mr. Robbins that, as I understood it, the processes of glass blowing were substantially the same whether applied to making Geissler tubes or to making the globes of electric lamps, and I advised him to see Dr. Adams, and ascertain what he had

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done in glass blowing. Sometime after, and in the month of September, I learned indirectly that Mr. Robbins had seen Dr. Adams, and in their discussion of the subject of Geissler tubes Dr. Adams had spoken incidentally of having made incandescent lamps with carbon burners several years prior to 1880. I at once sought an interview with Mr. Robbins, who corroborated this rumor, and thereafter, and on the same day, I went to Annisquam near Gloucester, Massa-
10902 chusetts, where Dr. Adams resides, and obtained his oral statement in regard to the matter. Since that time I have been diligently collecting evidence in corroboration of Dr. Adams statements, but have found that this required considerable time, owing to the difficulty of finding the witnesses whose names Dr. Adams gave me. One of them Mr. Aquila Adams, lived in New Hampshire, and I was obliged to go there to see him, and after preparing his affidavit and forwarding it to him at his residence for verification,
10903 I found, the latter part of last week, that he was away from home, and had not received the papers, and I then had the papers fowarded to him at Boston, where his verification was obtained on Saturday last; another of said witnesses, Mr. H. Julius Smith, was in Nova Scotia, and did not return until a few days since, and others I have not yet been able to find, owing to the lapse of time, and their having died or moved away from the places where they lived when Dr. Adams knew them.

10904 I am familiar with the proofs taken by both parties in this suit, and have consulted with the other counsel for the defendant as to the materiality of the evidence in regard to Dr. Adams' work now sought to be introduced, and I am of the opinion, and am so advised by defendant's counsel, that the said evidence is highly material, and in fact of the very first importance, upon the issues raised by the pleadings and the

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proofs, and that the interests of the defendant would be seriously prejudiced if it were not permitted to introduce the said evidence.

I do not know, and do not believe, that any of the officers, directors or counsel of the defendant had any knowledge or information in regard to any work of Dr. Adams in incandescent lighting prier to the time when I first obtained such information. It has been a part of my duty since I have been connected with the defendant, to collect and keep a record of all in- 10906
formation relating to adverse patents, and it has been the custom of the officers and directors of the defendant and other persons connected with it, to communicate to me promptly all such information, and I believe that if any person connected with the defendant had known of Dr. Adams having made such lamps he would have called my attention to it at once.

The present application for an order enlarging defendant's time to permit it to examine witnesses to prove the making and use of carbon incandescent 10907
lamps by Dr. Adams is not made for the purposes of delay; and I know of no reason why the taking of such proofs should delay the hearing of this cause materially, beyond the day at which, under existing stipulations and in conformity with existing understanding, it is likely that otherwise the cause would be ready for hearing.

LEONARD E. CURTIS.

Subscribed and sworn to before me, this 6th day of October, 1890. 10908

[L.S.] LORENZO C. CARNANA,
Notary Public,
Kings Co.
Certificate filed in New York Co.

10909

Adjourned to Saturday, October 18th, 1890, at 11 A. M.

NEW YORK, October 18, 1890.

Met pursuant to adjournment at the office of KERR & CURTIS, 120 Broadway, New York.

10910 Present: Counsel as before.

H. JULIUS SMITH, a witness produced on behalf of defendant, having been first duly sworn, testifies as follows in answer to interrogatories put to him by Mr WETMORE.

1 Q. Please state your name, age, residence and occupation?

A. H. Julius Smith. I am 47 years of age. I reside at Pompton, New Jersey, and am by occupation
10911 an electrician and manufacturer of electrical apparatus.

Counsel for defendant, in accordance with the suggestion of counsel for complainant and in order to save time, offers in evidence as part of the direct-examination a copy of the affidavit made by the witness on the motion for amending the answer, &c., and it is agreed that the following is a correct copy of said affidavit:

STATE OF NEW YORK,
10912 City and County of New York. } ss:

H. JULIUS SMITH, being duly sworn deposes and says: I am forty-seven years of age and reside at Pompton, New Jersey. From 1863 until about 1874 I resided at Boston, Mass., and was an expert mechanic for Moses G. Farmer, who was engaged in experi-

ments relating to electric light and other matters. 10913
During my residence at Boston I was acquainted with Dr. Isaac Adams, the inventor of the nickel plating process, who then resided there. I first became acquainted with him in 1864 or 1865 when he returned to Boston, as I understood at the time, from prosecuting his studies in medicine abroad. He had a small laboratory in South Boston at that time where I used to visit him occasionally; he was then engaged in glass blowing, particularly in making 10914
Geissler tubes, and in chemical work. My first visits to Dr. Adams' laboratory were in connection with his chemical work, but I took particular interest in his glass blowing work as I had never seen Geissler tubes made and exhausted before.

During the early part of our acquaintance, certainly within the first year, Dr. Adams discussed the subject of electric lighting with me. He knew of the work upon which I was engaged for Prof. Farmer from visits he made to the shop where such work was carried on, and he told me at various times that he felt 10915
sure that Prof. Farmer's work would not lead to any commercial result because, among other things, he was using platinum for the incandescent conductors of his lamps, and this was not a suitable material; that carbon in a vacuum was the only suitable material to be used for that purpose. He said that the carbon could be preserved from destruction when incandescent by enclosing it in a vacuum globe made and exhausted in precisely the same way as his Geissler tubes were made and exhausted. He spoke of the 10916
difficulty of preventing leakage from the expansion and contraction of the wires where they passed through the globes, and said that he had difficulty in obtaining a glass that would remain permanently sealed to the wires but that he had got over that difficulty by using a kind of glass that had substantially

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the same co-efficient of expansion as the planimum wires. I think he said he had had to make the glass himself in order to get the desired result. He stated that he had made a number of carbon lamps in that way, and found that they worked well and that the carbon lasted well, and showed me some of the lamps at the time. The lamps I saw consisted of a sealed glass globe with two wires sealed in and a thin strip of carbon enclosed in the globe and with each
10918 end attached to one of the wires. The globe was made of glass throughout and the wires where they passed through the walls of the globe appeared to be platinum and the glass was sealed directly to them. Dr. Adams stated to me at the time that the wires were platinum and that the joint was made by using the kind of glass he had referred to and fusing it directly to the wires. He further informed me that the globes were exhausted as completely as possible by means of the mercury air pump which he used for ex-
10919 hausting his Geissler tubes and which he showed me at the time. The carbons in the lamps which I saw were straight and about an inch to an inch and a hal long; they were about an eighth of an inch wide and very thin. I remember that my attention was particularly attracted at the time to the thinness of the carbons as they were much thinner than I had supposed carbon could be worked and hold together. These lamps I saw at Dr. Adams' laboratory in South Boston and afterwards he brought one of them to a machine shop in Sudbury Street where I had set up a
10920 dynamo machine which I had made and I ran the lamp on the machine for him. It gave a brilliant white light and worked well as long as we ran the dynamo which was half an hour or an hour, and the lamp was in good condition when we stopped.

I cannot fix the exact date when I saw the lamps at Dr. Adams' laboratory, but am sure that it was prior

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to 1868 as I never visited said laboratory after terminating my engagement with Prof. Farmer and that was terminated in 1867. The lamp was run on my dynamo after I left Prof. Farmer's employment, but not later than 1872. I took the machine away from that place early in 1873.

In my conversations with Dr. Adams which I have referred to above we discussed the general subject of electric lighting and he referred to the great expense of
producing electric current by any of the means known 10922
then as the most serious obstacle, and at the time an insuperable one, to the commercial introduction of electric lighting. He did not claim that the lamp he showed me involved any important invention but referred to it as the form of lamp that would naturally be used if electric lighting became practicable by the development of cheaper methods of producing electricity.

H. JULIUS SMITH.

10923

Subscribed and sworn to before me }
this 30th day of September, 1890. }

LORENZO C. CARUANA,
[SEAL] Notary Public, Kings Co.
Certificate filed in New York Co.

2 Q. Have you looked at the note-book produced by Dr. Adams upon his examination in this case and
the sketches therein contained, and, if so, will you 10924
please point out any of those sketches which represent the particular form of lamp which you remember to have run?

A. I should say that this one on page 1 does as near as my recollection will carry me in that matter, and also the sketch on the page facing the cover—I refer to those marked Dr. Adams Sketch No. 6 and

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Dr. Adams Sketch No. 7—It is barely possible that the one marked Dr. Adams Sketch No. 1 represents that lamp in an elongated form.

Cross examination BY MR. DYER:

3 x Q. In your affidavit you speak of visiting Dr. Adams' laboratory while you were working for Prof. Farmer, and that Dr. Adams knew of the work upon
10926 which you were engaged for Prof. Farmer. Was that work in connection with Prof Farmer's platinum or iridium lamp?

A. It was.

4 x Q. Did you also discuss with Prof. Farmer the work of Dr. Adams on this carbon lamp of his?

A. Not to my recollection.

5 x Q. You don't recollect whether Prof. Farmer ever mentioned the fact that he had seen or heard of Dr. Adams' carbon lamp?

A. No, sir.

10927 6 x-Q. Did you talk of Dr. Adams' lamp to any person employed by Prof. Farmer at the time?

A. No, sir; I was the sole employee.

7-x-Q. Did you talk of it at the time you saw it, to anybody other than Dr. Adams, that you recollect?

A. Not to my recollection.

8 x-Q. What kind of a dynamo machine did you have in the machine shop in Sudbury St., on which you say you ran Dr. Adams lamp for him?

A. A very poor one.

10928 9 x-Q. For what character of work was the machine intended?

A. For plating.

10 x-Q. With respect to the dimensions of the carbon in Dr. Adams lamp, which are given by you approximately in your affidavit, what is the basis of your statement?

A. The carbon appeared to be of about the same dimensions as Farmer used in his platinum-foil lamp. 10929

11 x-Q. What was the size of that?

A. About an inch or inch and a quarter in length, varying from a sixteenth to half an inch in width, and from a half of one-thousandth to three one-thousandths of an inch in thickness.

Cross-examination Closed.

H. JULIUS SMITH. 10930

Adjourned to meet at the Parker House, Boston, Monday, October 20th. 1890, at 11 A. M.

BOSTON, October 20th, 1890.

Met pursuant to adjournment.

Present: RICHARD N. DYER, Esq., of counsel for complainant. 10931

LEONARD E. CURTIS, Esq., of counsel for defendant.

AQUILA ADAMS, a witness produced on the part of the defendant, being first duly swern, testifies in response to interrogatories propounded by Mr. Curtis, as follows:

1 Q. Please state your name, age, residence and occupation? 10932

A. Aquila Adams, 58, Sandwich, New Hampshire, no occupation, have retired from business.

2 Q. Please examine the copy I now hand you of the affidavit made by you on October 4th, 1890, for use on the motion made in this case for leave to

10933 amend defendant's answer and take further proofs, and state whether the statements contained in said copy of said affidavit are true?

A. They are true.

Defendant's counsel in accordance with the suggestion made by Complainant's counsel, and for the purpose of saving time, reads
10934 said affidavit made by the witness, in evidence as a part of the direct examination, and it is agreed that the following is a copy of the same:

STATE OF MASSACHUSETTS, }
COUNTY OF SUFFOLK. } SS.

Aquila Adams, being duly sworn, deposes and says:

I reside in Sandwich, New Hampshire. I am a brother of the Isaac Adams, by whom the
10935 foregoing affidavit* was made, and I have read the said affidavit.

During the year 1865, and a part of 1866, my said brother lived at my house at Boston and I had a general knowledge of the work he was then doing from conversations with him, and occasional visits to his laboratory.

I knew of his experiments in electric lighting prior to 1865 from the fact that such experiments were made in my machine shop in
10936 South Boston, and when he commenced glass blowing, after his return from abroad in 1864, I became interested in his work, as I had never seen anything of the kind before, and I used to

* The affidavit of Isaac Adams' here referred to is printed as a part of his deposition on page 2685 above.

visit his laboratory occasionally, and observe the operation of making, exhausting and sealing Geissler tubes. 10937

During my visits to my brother's said laboratory at this time, I saw the incandescent electric lamps described in the foregoing affidavit and also different parts of the same in different stages of construction. The said lamps consisted substantially of a glass globe such as was used for some of the Geissler tubes 10938
made by my brother, with platinum wires sealed in in substantially the same way, except that both wires were sealed in at the same end of the globe, and a very thin slip of carbon enclosed in the globe and attached to the wires. The description contained in the foregoing affidavit is a correct description of the lamps I saw at the time referred to, and the sketch annexed to said affidavit correctly represents the same. My said brother explained the construction of said
lamps to me at the time and informed me that 10939
the globes of said lamps were exhausted as perfectly as possible by means of the mercury air pump he had, and I fully understood at the time that this was for the purpose of preserving the carbon from destruction when incandescent. I remember very distinctly that my said brother took great pains in making the joint between the glass of the globe and the platinum wires, and he then explained to me that in order to
secure a permanent seal at this place it was ne- 10940
cessary to use a peculiar kind of glass which had substantially the same co-efficient of expansion as platinum.

My attention was attracted to this point by the fact that in some of the first lamps he made

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the glass sleeves about the wires cracked, and he explained to me that this was because the glass was not of the right composition, and this defect was overcome afterwards by his making other glass which did not crack. I remember also very distinctly that the carbons were made very thin, as thin as they could prudently be worked and hold together.

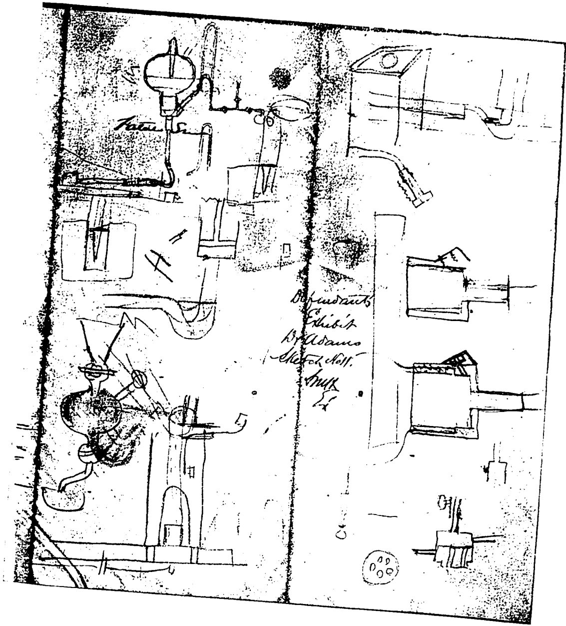
I am able to fix the date approximately when
10942 I saw the said lamps from the fact that it was while my said brother was living at my house and this was during the year and a half or two years immediately after my marriage in the latter part of 1864.

I understood from my conversations with my brother at the time that the lamps operated well and were durable, and I remember very distinctly having seen one of said lamps in operation at New York on an occasion when I
10943 went there with my brother. This was some years afterwards but certainly not later than the year 1874. He took one of my lamps with him, and ran it on a magneto machine. The lamp was of the same construction as those I had seen before at my said brother's laboratory and it worked well and gave a brilliant white light.

AQUILA ADAMS.

Subscribed and sworn to before me
10944 this 4th day of October, 1890.

WILLIAM B GALE,
Notary Public for Suffolk County.


Defendants
Exhibit
Dr. Adams
Sketch No. 11.

10929

3 Q. Have you since making this affidavit just referred to, found any sketches or memoranda among your papers which you recognize as having been made by your brother Dr. Isaac Adams, and which relate to the subject matter of your said affidavit, and, if so, will you please produce the same?

A. I have found a note-book and two scraps of paper containing sketches which I recogaize as having been made by my brother, and as relating to the electric lamp made by him and herewith produce the 10930 same.

Defendant's counsel offers in evidence said note-book and the two scraps of paper referred to, and the same are marked respectively, Defendant's Exhibit Dr. Adams Note-Book No. 4, and Dr. Adams' Sketch No. 11 and Dr. Aaams Sketch No. 12.

4 Q. Where did you find this note-book and these 10931 pieces of paper, and how long have they been in your possession.

A. I found them among my books and papers at Sandwich, and they have been boxed for six years and have been in my possession in my house since they were made.

5 Q. When were they made?

A. They were made during his residence at my house which extended from the latter part of 1864, to some time in 1866.

6 Q. What, if anything, do you find in these ex- 10932 hibits which you recognize as relating to the electric lamps made by Dr. Adams, and referred to in your affidavit?

A. I find on the eighth page of the note-book Exhibit No. 4, a sketch of an incandescent lamp near the lower right hand corner of the page which I recognize

10949

as being made by him and representing an incandescent lamp.

The sketch referred to is offered in evidence, and marked Defendant's Exhibit Dr. Adams Sketch No. 13.

On the paper marked Sketch No. 11, I find at the right of the centre of the sheet a sketch of an incan-
10950 descent lamp which I recognize as representing a sketch of an incandescent lamp made by my brother Dr. Adams. This paper also contains sketches of various other things among which I recognize sketches of a portion of a pump for forming a vacuum in Geissler tubes. On the paper marked Sketch No. 12, I find at the left, just below the centre a sketch which I recognize as being a sketch of an incanoescent lamp drawn by my brother Dr. Adams

7 Q. Are these sketches which you have produced
10951 all of the sketches of incandescent lamps made by your brother Dr. Adams during the time that he lived at your house and which were shown to you at the time and remained in your possession for some time after he left your house?

A. They are not. There were quite a number of other sketches of various forms of incandescent lamps which were destroyed when I moved my books and papers as being of no value.

8 Q. How did you happen to be in possession of those sketches, both the ones that were destroyed
10952 and those you have produced?

A. He lived at my house during the time they were made and when he left he left the sketches, at my house. When I moved many of them were destroyed. Those that I have I found in various books, that is, they were not put away with a view to their preservation, they were in the books as book marks or where he had used the books as a surface to draw upon. My brother probably left them at my house thinking they were of no value.

10953

9 Q. How are you able to say that the sketches Nos. 11, 12 and 13 represent incandescent lamps?

A. From conversations that occurred at the time and from my general knowledge of electric lamps and also from seeing him make the sketches and the lamps.

10 Q. How do the sketches referred to correspond to the lamps which you saw made by your brother?

A. Very similar to them, as a matter of fact the sketches are on too small a scale to determine whether 10954
he made the lamps exactly like them. I did not happen to find a perfect drawing.

11 Q. How did the sketches which you say were destroyed compare with these you have produced in scale and completeness of detail?

A. Many of them were on a much larger scale, some half size and some full size, and some as small as are these particular exhibits. Some of them, those drawn on half and full size were complete in detail—complete enough in detail to enable a person skilled in the art 10955
to contruct one.

12 Q. How did the sketches of lamps to which you have referred happen to be made and for what purpose were they made, so far as you know?

A. For the purpose of making a lamp by; one of the purposes was for making a miner's light, and another was to produce a light for general use.

13 Q. Please examine the sketches already offered in evidence and marked Dr. Adams Sketches Nos. 1 to 10 inclusive, and state whether you have seen these particular sketches before? 10956

A. I have undoubtedly seen them all before. I recognize the note-book and the sketches.

14 Q. When did you see them?

A. It would be hard for me to tell when I saw them. There are other sketches of these same things that I have seen—for instance, I have seen them

10957 sketched upon a piece of paper. I should say I saw them between 1865 and 1868 and undoubtedly some that were made later, possibly as late as 1874.

15 Q. During what years did you visit your brother's laboratory in South Boston most frequently where he was at work upon the electric lamps as you have stated in your affidavit?

A. In 1866 and in 1867. We went abroad in the early part of 1867.

10958 16 Q. Did you visit his laboratory after that time?

A. Occasionally, seldom.

17 Q. Did you see incandescent lamps there after 1867?

A. I did.

18 Q. To which, if any, of the sketches marked Dr. Adam's sketches Nos. 1 to 13 inclusive and the sketch attached to the affidavit forming a part of Dr. Adams' direct testimony, did the incandescent lamps you saw at your brother's laboratory during the years

10959 you have mentioned correspond?

A. The sketch contained in the affidavit; I have also seen lamps made like sketches Nos. 6 and 7, also, like sketch No. 4. I recollect the discussion about sketch No. 5, but I don't recollect the lamp.

19 Q. Did you see the incandescent lamps made by your brother during the times you have mentioned lighted by applying an electric current to them?

A. I did.

20 Q. Where and at what time?

10960 A. One that I recollect most distinctly I saw in operation in New York at the Nickel Plating works, working under the Adams patents. That was not later than 1874 and my impression is it was in 1873.

21 Q. Had you seen any of them operated before that time?

A. I have an indistinct recollection that I have seen them operated at his laboratory.

22 Q. How are you able to say that it was not

later than 1874 that you saw the lamp operated in New York? 10961

A. I have not been to New York since 1874.

23 Q. What was the construction of this lamp you saw operated in New York as compared with those you had seen before at your brother's laboratory with respect to the size of the carbon and the construction of the globe and the sealing in of the wires?

A. In answer to that I should say it was substantially like the sketch attached to my brother's affidavit 10962
but the globe of larger diameter than drawn. The wires were sealed in the same way. The carbon was about the same size as those in the lamps I had seen before.

AQUILA ADAMS.

Adjourned for luncheon.

JAMES E. THATCHER, produced as a witness on the part of the defendant, being duly sworn, testifies in 10963
response to interrogatories propounded by Mr. Curtis.

1 Q. Please state your name, age, residence and occupation?

A. James E. Thatcher, age 58, iron founder, residence Boston, Massachusetts.

2 Q. Are you acquainted with Dr. Isaac Adams and Aquila Adams, and if so, how long have you known them?

A. I am, and have known them from their childhood.

3 Q. Did you go abroad with them at any time, and, 10964
if so, in what year?

A. I did, in 1867.

4 Q. Do you remember the circumstance that you parted company with Dr. Adams during that trip, and if so, where was it arranged that you should meet him?

A. We parted at Florence with the understanding

10965 that we should meet at Munich.

5 Q. Please look at the sketch now shown you, Defendant's Exhibit, Dr. Adams Sketch No. 4, and state whether or not you have seen it before?

A. I cannot say that I ever saw this same one, but a great many very similar to it drawn by him, Dr. Adams, at various times during our journey in 1867.

6 Q. What were the sketches made to represent?

A. As he said, a miner's lamp.

10966 7 Q. Did he tell you by what agency the lamp was to be operated. If so, what?

A. He said it was a miner's electric lamp.

8 Q. Did he explain the details of construction to you at that time?

A. He may have, I think he did, but it is so long ago that I cannot remember the details now.

Cross-examination BY MR. DYER:

10967 $8\frac{1}{2}$ x-Q. Are you, or were you in 1867, an electrician?

A. I was not.

9 x-Q. Did you understand the construction or operation of this apparatus which Dr. Adams proposed at that time?

A. I did not.

10 x-Q. Did you at that time, know whether it was to be an arc lamp or an incandescent lamp?

A. I did not.

10968 *Re-direct-examination:*

11 r-d-Q. Has anything in the recent development of electric light, recalled to your mind the circumstance of Dr. Adams miner's lamp having been explained to you, if so, what?

A. When I first saw that little short globe with a

10969

light in it, it recalled the lamp he used to make and I often thought it might be something similar to what he was drawing.

12 r d-Q. By the the "little short globe with a light in it" do you refer to the small electric lamps that have come into use during the past ten years for lighting stores and houses?

A. I do

13 r d-Q. Do you know what those lights are called?

A. I do not. 10970

Re Cross Examination .

14 r-x-Q. Were you intimately acquainted with Dr. Adams before this trip in 1867 and afterwards?

A. I was.

14 r-x-Q. Did he ever show you one of these electric lamps which he made sketches of in 1867?

A. Only the sketches.

JAS. E. THATCHER. 10971

DR. ISAAC ADAMS, recalled and examined by Mr Curtis.

107 Q. Have yo found the glass bulb with ruby glass referred to in your cross-examination and also in your answers to the re-direct questions 105 and 106, and, if so, will you produce it?

107 Q. This is the thing that I referred to. The bulb is a portion of a carbon incandescent lamp and was made as far back certainly as 1867, and probably before that. I recognize its age from the general construction of it and also from the fact that the body of the globe was blown by me and not at the glass house, and that the body of glass is of the kind called lime- 10972

10973

glass by the makers. The ruby glass is of a different composition.

Defendant's counsel offers the glass bulb produced by the witness in evidence and the same is marked, Defendant's Exhibit Glass Bulb of Dr. Adams Incandescent Lamp.

108 Q. Was the long stem now attached to the bulb
10974 a part of it when the bulb was, as you have stated, used as a part of an incandescent lamp?

A. No. The stem that is attached was put on after the lamp part was broken off. I first tried one end and then the other, the lamp part of it cracked off at the joint and I started to repair it and I did actually try to make a union between the different kinds of glass, first on one end and then on the other. Something occured to call my attention to other things, and I never completed it.

10975 109 Q. Please look at the Defendant's Exhibit Dr. Adams Note-Book No. 4, and Dr. Adams Sketches Nos. 11, 12 and 13, and state whether you recognize them, and if so, what they are.

A. I recognize all of them. The Note-Book No. 4 is one of the books that I bought in Cambridge when I commenced my studies there in 1858, and the handwriting in the book is mine. The paper entitled Dr. Adams Sketch No.11 consist of a number of sketches of different apparatus among which I recognize a sketch of a part of a mercury pump and apparatus
10976 connected therewith, a sketch of a blast gas lamp, and a small sketch of what appears to be an incandescent lamp. It is partly effaced by wear and tear but from its general outline I recognize it as the thing I have mentioned. The Sketch No. 12 has on it a very similar form of lamp, but small and indistinct, but I have no doubt it was meant for a sketch of an

incandescent lamp. I recognize two other sketches 10977
on this paper, one of them is an ink drawing of a lamp I got up, a blast gas lamp which I actually had made and used for heating crucibles in my laboratory and for glass blowing. The sketch in the note-book No. 4 marked Dr. Adams sketch No. 13, is also an incandescent lamp of substantially the same form. The sketch at the left of the same page I recognize as the lecture form of apparatus for exhibiting the arc electric light in a vacuum; the lower carbon is fixed, the brass holder of the upper carbon slides through a 10978
stuffing-box after the vacuum is made. That is, the carbons are brought into contact after a vacuum is made.

110 Q. By whom were the sketches No. 11, 12 and 13 made, and when?

A. I have no doubt that I made them. Everything that I see in the book is in my handwriting or in figures made by me. The sketches are drawings of different apparatus I devised at various times for my own use. The sketches all refer to apparatus which I 10979
made or had in use when I had a laboratory of my own which must have been in 1860 and later. I have no means of knowing absolutely when the sketches were made, but from the nature of them, they must have been made very early in my experiments in chemistry and physics. They must have been made previous to 1866, the whole of them. I left my brother's house in that year, and I have never seen the book since, that I know of.

Cross-examination by Mr. Dyer.

111 x-Q. Referring to the glass bulb which you 10980
have produced, what operations have been performed on this piece of glass since the lamp part was broken off, as you state?

10981 A. I fused on an end similar to the one there is there now in order to use the other end of the lamp, hoping that the glass would hold, then in order to handle tha apparatus I fused on the end which is now on it intending to put the lamp in the other end if the glass held, which it did not.

112 x Q. Then subsequent to the lamp part being broken out you fused a tube first on to one end and then on to the other end of this bulb, the second tube breaking off of the bulb?

10982 A. Yes, that's right.

113 x Q. What did you fuse the second tube onto the bulb for?

A. To get a lead glass base to put the platinum in.

114 x Q. As this glass bulb is at the present time does it show any evidence of its use as part of an electric lamp?

A. No, it does not.

115 x Q. It calls to your mind, as I understand you,
10983 one of your experiments in securing a durable seal between a glass bulb and a large platinum conductor?

A. Yes.

116 x Q. In your last examination you referred to Figure 3 of your patent No. 282,030, as not inteded to represent a lamp, what criticism, if any, do you desire to make in regard to the structure shown in Figures 1 and 2 of the patent?

A. Figures 1 and 2 represent the form of a lamp I proposed to use.

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Re-direct BY MR CURTIS:

117 r-d Q. Was the glass bulb you have produced used at an early or late period of your experiments?

A. It was used at a very early period. I know this for the reason that it is an attempt to use a lime glass body of the ordinary glass that I used, with lead glass ends. I abandoned that manner of making bulbs for the reason that my experiments in lime glass were such as to lead me to think that lead glass was preferable 10986
for holding very heavy platinum.

ISAAC ADAMS.

NEW YORK, October 24th, 1890.

Met at the office of KERR & CURTIS, No. 120 Broadway, New York City, pursuant to notice.

Present: RICHARD N. DYER, ESQ., of Counsel for Complaint.

LEONARD E. CURTIS, ESQ., of Counsel for Defendant. 10987

Defendant's counsel states that the lamp marked Defendant's Exhibit Model of Dr. Adams' Lamp of 1868, has been accidently broken in handling the same, and offers in evidence another lamp made by the same person. It is stipulated that the said lamp now offered was made by the same methods and from the same instructions as said broken lamp, with the intention of having it substantially the same as 10988
said broken lamp, and that it is substantially the same except in the electrical measurements, which are as follows for the lamp now offered: 13 volts, 18.8 amperes and 40 candle power, corresponding to a resistance hot of about .69 of an ohm.

The lamp is marked Defendant's Exhibit Model No. 2 of Dr. Adams' Lamp of 1868.

10989

U. S. CIRCUIT COURT,

SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT CO. vs. THE U. S. ELECTRIC LIGHTING CO.	In Equity, No. 3,445.

10990

Met pursuant to notice at the office of Messrs. Kerr & Curtis, No. 120 Broadway, New York City, at ten o'clock, A. M., Nov. 15, 1890.

Present:—

SAMUEL A. DUNCAN, ESQ., and
LEONARD E. CURTIS, ESQ.,

Counsel for Defendant.

10991 Counsel for defendant offers in evidence a notice to Messrs. Jacob H. Herrick and F. S. Hastings with proof of service. The same is marked "Defendant's Exhibit Notice to Herrick and Hastings."

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Defendant's Exhibit Notice to Herrick and Hastings.

UNITED STATES CIRCUIT COURT,

SOUTHERN DISTRICT OF NEW YORK..

THE EDISON ELECTRIC LIGHT COMPANY. vs. THE UNITED STATES ELECTRIC LIGHTING COMPANY.	In Equity, No. 3,445.

10994

Please take notice that the Examiner in the above entitled suit will be in attendance at our office in the Equitable Building, No. 120 Broadway, New York, on Saturday next, November 15, 1890, at 10 o'clock in the forenoon. for the purpose of enabling you to comply, 10995
if you be so advised, with the order of the Court made and filed November 5, 1890, of which copy has heretofore been served upon you, in regard to the production of certain papers referred to in said order.

Very respectfully,

KERR & CURTIS,
Solicitors for Defendant.

To—MESSRS. JACOB H. HERRICK and
F. S. HASTINGS.

10996

City and County of New York, ss. :—

EDWIN HOPKINSON, being duly sworn, deposes and says: I am fourteen (14) years of age; reside in Brooklyn, New York, and am a clerk in the law office of Kerr & Curtis, at 120 Broadway, New York. On

10997 the 14th day of November, 1890, I served the foregoing notice upon Jacob H. Herrick and F. S. Hastings, at No. 44 Wall street, in the City of New York, by delivering to, and leaving with, each of the above persons, personally, a true copy of the said notice.

EDWIN HOPKINSON.

Sworn to before me this 15th day of November, 1890.

10998 SAMUEL M. HITCHCOCK,
U. S. Commissioner.

At 11 A. M., counsel for complainant appear as follows:

GROSVENOR P. LOWREY, Esq.,
S. B. EATON, Esq., and
RICHARD N. DYER, Esq.

Mr. Frank S. Hastings, secretary of the complain-
10999 ant, was present and offered himself as a witness, having formerly been sworn. He states as follows:

I have been shown the order of the Court entered in this case on the fifth of November. At my request Mr. Dyer has handed to me a bundle of papers which he informs me are all which he now has, or has ever had, coming within the description in the order or in subpœna *duces tecum* formally served on me. I now produce them in obedience to the order and hand them to Mr. Lowrey, one of the counsel for the complain-
11000 ant, without privilege of counsel in him, and without prejudice to complainant's right, as it may be advised, to refuse exhibition of the papers to the defendant or its counsel until the further order of the Court, and without prejudice to its right to object to the introduction of the same in evidence.

In response to questions by MR. LOWREY:

1 Q. The parcel of papers you now hand me, marked

11001
"Incandescent Electric Lamp, filed December 15,1880," and marked with the number 22,301, from whom did you receive these papers, and when?

A. From Mr. Dyer, this morning.

2 Q. Have you examined them since receiving them?

A. I have not.

3 Q. Do you believe this parcel to contain all the papers of the Edison Electric Light Company coming within the description of the papers in the subpœna 11002
formally served on him?

A. I do.

4 Q. Do you believe Mr. Herrick has any other papers coming within the description in the subpœna served upon him?

A. I know that he has no others.

5 Q. Do you know where these papers have been during the pendency of this suit?

A. They have been in the possession of our patent attorney, Messrs. Dyer & Seeley. They have never been in our office. 11003

Examined by GENERAL DUNCAN.

6 Q. How do you know that Mr. Herrick has no papers relating to this matter?

A. From personal statements made to me by him; and for the reason that Mr. Herrick has only been President of the Company during the past year, while I have been in the Company for upwards of nine years, and papers of this description are always filed in my office as Secretary, and I know that they never come 11004
into the possession of Mr. Herrick.

7 Q. Has Mr. Herrick delegated you to represent him here to-day or to testify in his behalf?

A. He has not.

8 Q. Where is Mr. Herrick to-day if you know?

A. Mr. Herrick had an important business engage-

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ment up town, but will be in his office some time during the day.

9 Q. Have you some doubt as to whether the papers which you have brought with you and handed to complainant's counsel constitute a complete file of the papers composing the application for patent made by Mr. Edison on December 15, 1880, and referred to in the subpœna heretofore served upon you, and of the correspondence between the applicant or his assignee and
11006 the Patent Office during the prosecution of such application?

A. I have no such doubt.

10. Have you examined the papers which you have brought here this morning, and which you have handed over to Mr. Lowrey?

A. I have not.

11 Q. Then you don't know, I presume, whether they are the papers called for by the subpœna?

11007 A. Not of my own knowledge.

12 Q. In fact, these papers were brought into the presence of the Examiner this morning by Mr. Dyer, by him handed to you, and by you handed unexamined to Mr. Lowrey in connection with the statement with which your examination opened?

A. Yes.

13 Q. What effort have you made to verify the character of these papers in order to determine whether they are the papers, and all of the papers, called for
11008 by the subpœna?

A. I have not done so, but will immediately.

Mr. Hastings proceeds to examine the parcel, and says:

I have examined the papers, and believe that they are the papers, and all of the papers, called for by the subpœna.

14 Q. When you received these papers this morning from Mr. Dyer, why did you hand them to Mr. Lowrey?

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A. Acting under the advice of counsel.

15 Q. You were advised not to hand them to the Examiner?

A. I was not so advised.

16 Q. You were advised to hand them to Mr. Lowrey?

A. Yes sir.

17 Q. You knew that he was counsel for the complainant, did you not?

A. Yes, sir, I did 11010

18 Q. Is he also your personal counsel in this matter?

A. I have no personal counsel in this matter.

19 Q. Who advised you to hand the papers to Mr. Lowrey?

A. The general counsel of the Company.

20 Q. Please name him?

A. Mr. Eaton.

21 Q. You considered, then, that was in full compliance with the order of the Court, did you? 11011

A. I did not consider the matter at all.

22 Q. Did you understand that the only object in handing these papers to Mr. Lowrey was to prevent them being inspected by defendant's counsel?

A. I did not so understand it.

23 Q. Do you know why Major Eaton gave you this advice?

A. I do.

24 Q. Why did he so advise you?

A. I understood it to be, that the papers were to be given to Mr. Lowrey with the understanding that the 11012
question as to whether they should be finally submitted to the Court was one still to be argued.

25 Q. You knew that they were previously in the hands of Mr. Dyer, did you not?

A. I did.

26 Q. You knew that he was one of the counsel of

11013 the Edison Electric Light Company, did'nt you?

A. I did.

27 Q. And you supposed that you were complying with the order of the Court by transferring the papers to Mr. Lowrey?

A. I had no such supposition; no, sir.

28 Q. Do you now think that by doing that, you have complied with the order of the Court?

A. Not technically; no, sir.

11014 29 Q. Well, do you now think that you complied technically with the order of the Court?

A. I know nothing about it, sir; I could not act intelligently without advice of counsel.

30 Q. Inasmuch as you have no counsel, as you have stated, and, inasmuch, therefore, as Major Eaton is not your counsel, do you think, that in a matter of this kind, it is entirely safe to take the advice of counsel of the Edison Electric Light Compay?

A. I do, sir.

11015 31 Q. Will you now hand the papers which you received from Mr. Dyer, and which you have given to Mr. Lowrey, to defendant's counsel for examination, in order that defendant's counsel may see whether they are in fact the papers called for by the subpœna?

A. Not without being advised to do so by counsel.

32 Q. Then you are willing as I understand it, to rest your personal relations with the Court in this matter with the counsel of the Edison Electric Light Company?

11016 A. I am sir.

33 Q. Will you hand these papers which were brought here by Mr. Dyer, and by you given to Mr. Lowrey, to the Examiner, to be by him marked, each and all, for identification?

A. No, sir

34 Q. Why do you decline to do so?

A. I will do so under advice of counsel—counsel of the Edison Electric Light Company.

11017

Defendant's counsel offers in evidence the subpœna which was served upon the witness Hastings on June 30th, 1890, and the same is marked "Defendant's Exhibit Hastings' subpœna."

35 Q. Please examine defendant's exhibit Hastings' subpœna and state whether that was the subpœna served upon you?

A. I presume that it is; I have not a written copy of 11018 the subpœna that was served upon me. I cannot identify it positively.

F. S. HASTINGS.

Defendant's counsel gives notice that on Friday next, the 21st inst., at 11 o'clock in the forenoon, or as soon thereafter as counsel can be heard, he will move before the United States Circuit Court, at the Court House, in the City of New York, for the punishment of Frank S. Hastings for contempt for his failure 11019 to obey the order of the Court made and filed on the 5th day of November, 1890.

Defendant's Exhibit Hastings' Subpoena.

THE PRESIDENT OF THE UNITED STATES OF AMERICA, to FRANK S. HASTINGS, *Greeting:*

We command you, That all business and excuses being laid aside, you appear and attend before Samuel M. Hitchcock, one of the Examiners of the Circuit 11020 Court of the United States for the Southern District of New York, at the offices of Duncan & Page, at 120 Broadway in the City of New York, on the 30th day of June, 1890, at 2 o'clock in the afternoon, to testify and give evidence in a certain suit in equity now pending undetermined in the Circuit Court of the United States for the Southern District of New York, between The Edison Electric Light Company, complainant, and The United States Electric Lighting Company, defendant, on the part of the said defendant, and that you bring

11021 with you and produce at the time and place aforesaid,
any copy, whether certified or uncertified, that you, as
Secretary of the Edison Electric Light Company, now
have in your possession or custody, or under your con-
trol, or which the said company, or any officer, attorney,
solicitor or agent of said company, has in its or his
possession or custody, or under its or his control, of
the specification and claims, and of the drawing, which
11022 formed a part of a certain application for letters patent,
relative to incandescent electric lamps, filed in the
Patent Office of the United States by Thomas A. Edi-
son on or about the 15th day of December, 1880, under
the serial number, in the special series of Edison ap-
plications of No. 264, the same being a divisional
application divided off from an earlier application
(Edison's Serial Number thereof being 187) filed by the
said Edison on or about December 11, 1879; and also
the original and copies, whether certified or uncerti-
11023 fied, now in your possession or custody, or under your
control, or in the possession or custody or under the
control of the said company, or of any of its officers,
attorneys, solicitors and agents, of any and all corres-
pondence that has passed between the Patent Office
and the said Edison or the said company, or his or its
attorney or attorneys, or agents, in relation to the said
application, including all amendments of the said ap-
plication that may have been made from time to time,
and all other deeds, evidences and writings, which you
11024 have in your custody or power, concerning the prem-
ises. And for failure to attend, you will be deemed
guilty of a contempt of Court, and liable to pay all
loss and damages sustained thereby to the party ag-
grieved, and forfeit two hundred and fifty dollars in
addition thereto.

Witness, the Hon. Melville W. Fuller,
Chief Justice of the Supreme Court of the
United States, at the City of New York,
the 30th day of June, 1890.

John A. Shields,
Clerk.

Mr. Jacob H. Herrick, president of the complain- 11025
ant, was present and offered himself as a witness, hav-
ing formerly been sworn, and made a statement as
follows:

I have been shown the order of the Court entered
November 5th, 1890, and signed by E. Henry La-
combe, Judge, in which it is ordered "that the said
Herrick and the said Hastings produce the said papers
as required by the aforesaid subpœna within ten days
hereof, or show cause before me why they should not 11026
be punished for contempt in disobeying the commands
of this Court." I appear voluntarily in order to com-
ply with the order.

I am informed that before my arrival Mr. Hastings,
the Secretary of the Edison Electric Light Company,
who was also subpœnaed to bring the same papers
that are described in the *subpœna duces tecum*, formal-
ly served upon me, has been present before the Exam-
iner, and handed to Mr. Lowrey, one of the counsel, a
bundle of papers received by him from Mr. Dyer, one 11027
of the attorneys. I have now been shown a parcel of
papers by Mr. Lowrey which he represents to me are
the papers handed by Mr. Hastings to him. I have
looked hastily through the parcel, and am sure I have
never seen any of these papers before. I have no rea-
son to doubt the representation of Mr. Dyer that they
are the papers, and all of the papers, belonging, or
which have ever belonged, to the company coming
within the description of the *subpœna duces tecum*. I
am told that these papers had their origin several
years ago, and before I had any connection with the 11028
company. Neither they, nor any similar papers, have
ever been in my control since my connection with the
company. Whatever papers of this sort the company
has at any time had, or could have had, during my
connection with it, would be in the custody of Mr.
Hastings, unless placed in the hands of patent solici-

11029 tors or lawyers in some litigation in which this company is interested, for their use.

Examination by MR. DUNCAN:

1 Q. You say these papers "originated several years ago"; what do you mean by that?

A. I mean that prior to my connection with the company, in the Spring of 1889, these papers were in
11030 existence—that is, prior to my connection with the company in May, 1889.

2 Q. How long prior?

A. From six to nine years.

3 Q. *All* of them from six to nine years?

A. I know nothing, except that the box which contains these papers has the dates on the outside. I will examine each of the papers it you desire me to do so in order to verify these dates; but the dates appearing on the outside range from 1880 to March
11031 1889, and my connection with the company began in May, 1889.

4 Q. Will you let defendant's counsel take these papers to verify your statement in regard to them?

A. No, sir.

> Mr. Lowrey asks the witness whether he, not having been present at the early part of the examination, desires any advice at this point. The witness says he does. In the hearing of the Examiner and counsel for de-
> 11032 fendant counsel for the complainant advises Mr. Herrick to decline to allow, at this time, an examination of the papers.
>
> The statement of Mr. Hastings, made before the Examiner, accompanying the handing of the papers to Mr. Lowrey, is now read to the witness.
>
> The witness states that he desires to modify

> his answer in accordance with the advice of counsel hereinbefore mentioned, and requests the counsel to take the order of the Court and to act in accordance therewith. 11033

5 Q. Why do you refuse to permit these papers to be examined by defendant's counsel?

A. Pursuant to advice of counsel, and in accordance with the statement I have made.

6 Q. For no other reason? 11034

A. For no other reason.

7 Q. Then you consider that these papers are now in the custody of Mr. Lowrey and not in yours, do you?

A. My statement covers the actual possession of the papers at present.

8 Q. You regard them as in the physical possession of Mr. Lowrey, do you?

A. I regard them as in the possession of the parties stated in my previous answer.

9 Q. That party was Mr. Lowrey, was it not?

A. Yes, sir. 11035

10 Q. Is Mr. Lowrey your personal counsel in this matter?

A. Yes, sir.

11 Q. When did you retain him for this purpose?

A. The moment I received this notice I requested Major Eaton, General Counsel of the Company, to obtain proper counsel for me.

12 Q. And he retained Mr. Lowrey for the purpose, did he?

A. Yes, sir. 11036

13 Q. Do you regard Major Eaton your personal counsel in this matter?

A. Partially.

14 Q. What do you mean by partially?

A. I do not hesitate to ask his advice if I desire it, and should expect to pay for it if I did so.

11037

15 Q. In that sense, I suppose you may say that any reputable lawyer, not engaged on the other side, might be looked upon as your counsel?

A. I don't see that that requires any answer.

16 Q. Do you consider that by taking the papers
referred to in the order of the Court of November 5th,
1890, and sending them to your personal counsel "with-
out the privilege of counsel in him," or handing the
11038 papers to the counsel of the Edison Electric Light
Company, with the understanding that you are there-
by making such disposition of the papers that they can
not be inspected by the counsel for the defendant in
this case, you are complying with the said order of
the Court?

> Mr. Lowrey inquires of the witness whether he wishes any advice upon that point.

> 11039 Defendant's counsel objects to the cross-examination of the witness being interrupted for the purpose of permitting the counsel for the complainant to suggest to the witness the answer which he is to make.

> Mr. Lowrey, as counsel, informs the witness that, in his opinion, the delivery of the papers as above described is a strict and due compliance with the order of the Court.

> 11040 Defendant's counsel states that as complainant's counsel has taken the position of witness, and made his last suggestion in the presence of the witness, it would be folly to press the question.

17 Q. You have not examined the papers here presented, but in the physical possession and custody of Mr. Lowrey, in order to determine whether they are the papers called for by the subpœna, have you?

A. I have never seen the papers until I came here.

11041

18 Q. Then you do not know, except on the assurance of the other gentlemen, that these are the papers called for by the subpœna, do you?

A. I do not at this moment know, but I will examine the papers now, if you desire me to do so, for the purpose of verifying them; but perhaps the examination which Mr. Hastings is making will serve your purpose, as I am entirely unfamiliar with this class of papers, and have to take the opinion of the lawyers.

> Defendant's counsel states that on this ad- 11042
> mission of the witness he has certainly no desire to have him consume time in making the examination which he has suggested, but which the defense has not called for.

19 Q. Will you hand the papers, which have been brought in here ostensibly in obedience to the subpœna to the Examiner to have him mark them each and all for identification.

A. The papers are to be handed to him by the coun- 11043
sel to be sealed; after that I do not think it necessary
to interfere further with them.

20 Q. Then you decline to take them from Mr. Lowrey's custody and hand them to the Examiner, do you?

A. Yes, sir.

JACOB H. HERRICK.

> Defendant's counsel gives notice that he
> will move under the order of November 5th,
> 1890, on Friday next, the 21st, at 11 o'clock
> in the forenoon, or as soon thereafter as coun- 11044
> sel can be heard, before the United States
> Circuit Court, at the Court House in the City
> of New York, for the punishment of this wit-
> ness for contempt in failing to obey the afore-
> said order.

11045 RICHARD N. DYER, having already been sworn in the case, testified as follows, in response to questions by Mr. Lowrey:

1 Q. Mr. Dyer, you are one of the attorneys of the complainant herein, are you?

A. I am.

2 Q. I hand you a paper box marked on the outside, "Incandescent electric lamp," filed December 15,
11046 1880, and numbered 22,303, and ask you if that parcel is what it purports to be, and who brought it at this meeting, before the Examiner this morning?

A. This parcel is an office file, containing the original copies of papers connected with an application for a patent by Mr. Edison, filed December 15, 1880, and referred to in the *subpœna duces tecum* heretofore served upon Mr. Herrick, Mr. Hastings, and myself, and also referred to in the order of the Court of November 5, 1890.

11047 3 Q. Where have these papers been, if you know, during the pendency of this application—in whose custody?

A. In my custody up to this morning.

4 Q. From what time?

A. From August, 1882.

5 Q. Have they ever been out of your personal custody during that time?

A. No, sir.

6 Q. And where have you kept them during that
11048 time?

A. In my office.

7 Q. Is that the office of the Edison Electric Light Company?

A. No, sir, it is not. It is the office of Dyer & Seely, attorneys-at-law.

8 Q. Please state whether the parcel which you now hold in your hand contains all of the papers, which you now have or ever had, in your possession, described in the subpœna and order herein referred to?

A. It does; all of them. I have looked through the parcel and believe it contains all the papers mentioned in the subpœna. 11049

9 Q. Have you recently gone through the papers with Mr. Hastings, if so, for what purpose, and with what result; do you find the papers all there which you ever had in your possession coming within the description of the *subpœna duces tecum* herein?

A. I looked them over with Mr. Hastings after he was asked the thirteenth question of his deposition 11050
this morning, in order that he might see whether they appeared to him to be the papers called for by this subpœna. I have recently looked them over myself in addition to this examination with Mr. Hastings, for the purpose of having copies made. No papers appear to be missing from the file, and I can state with entire confidence that the papers in this file are all the papers that I now have, or ever have had, relating to this application.

10 Q. By "file" do you mean the paper box in which you brought the papers to the meeting this morning? 11051

A. I do.

Counsel for complainant states that he will now request the Examiner to go through the file of papers, and put upon each individual paper any mark which he may deem necessary for identification, and that he will then with Mr. Dyer, seal up the box with a seal, and hold them subject to the further order of the Court. And counsel also states that 11052
copies have been made of the papers for the convenience of the Court and of counsel for defendant in case the Court shall order the same for examination.

Defendant's counsel asks Mr. Lowrey, from whom the last statement has proceeded, whether, in making that statement, and making that

11053

request of the Examiner, he is acting as counsel for the Edison Electric Light Company, the complainant, or as counsel for Mr. Herrick.

Mr Lowrey, complainant's counsel, answers that he is acting entirely as counsel for the Edison Electric Light Company, and that he has not given, at any time, any advice to Mr.
11054 Herrick or Mr. Hastings upon this subject, except in their respective capacities as officers of the Complainant company.

To prevent misapprehension, defendant's counsel further inquires whether Mr. Lowrey regards himself as counsel for Mr. Jacob H. Herrick?

Mr. Lowrey replies that he has never been asked by Mr. Herrick, or any one for him, to
11055 act as his counsel.

Defendant's counsel further inquires whether Mr. Lowrey has received, and now holds, the papers brought to the examination room this morning by Mr. Dyer, as counsel for the Edison Electric Light Company.

Mr. Lowrey states that he is counsel for the Edison Electric Light Company in this suit; that he has received from Mr. Hastings the papers described, and that he now holds them. He intends to submit them to the or-
11056 der of the Court in his character of counsel to the Edison Electric Light Company, and that according to his understanding, the individual officers who were subpœnaed, have fully complied with the order of the Court by producing the papers, and that the papers are produced within the sense of the law and the meaning of the order by being in the hands of the counsel, or in the custody of the Ex-

11057

aminer, to be handed to the Court; beyond this Mr. Lowrey desires not to enter into any exposition of the legal character in which he holds papers, not deeming it necessary for any purpose.

Defendant's counsel objects to the proposed line of action on the part of counsel for the complainant against the sealing up of the
papers in question by the Examiner without 11058
the opportunity on the part of defendant's counsel of inspecting same; and defendant's counsel now, and here, demands the inspection of the said papers.

Examination of Mr. Dyer by defendant's counsel, Mr. Duncan:

11 Q. When you became professionally connected
with the Edison application of December 15, 1880, 11059
did you receive a file of all papers in the case up to that date?

A. I did.

12 Q. These papers which you brought here this morning, according to your understanding and belief, constitute a complete file of the papers connected with this application, do they?

A. As to that I am not entirely certain. There are formal portions of the papers of which copies were not retained.

13 Q. What do you mean by "formal portions"? 11060

A. By formal portions I mean such as the formal petition and oath to the application, and possibly other similar papers; also I see that a portion of the papers, being retained copies, are not entirely complete as regards signatures, dates, etc., and I am not entirely certain that this file contains every paper which will be found in the file in the Patent Office. It does, however, contain every retained paper which has ever been

11061 in my possession relating to the case.

14 Q. These papers were brought to the examination room this morning by yourself, were they?

A. Yes, sir.

15 Q. You delivered them to Mr. Hastings with the expectation and understanding that he would hand them at once to Mr. Lowrey, did you not?

A. I said nothing of the kind to Mr. Hastings; I handed them to him without qualification; I person-
11062 ally had that expectation

16 Q. What produced that expectation in your mind?

A. A previous discussion of the matter with Mr. Lowrey.

Mr. Lowrey states that the course which has been pursued during this examination has been perfectly in accordance with the advice previously given by him in respect to it.

11063 17 Q. Do you know of any reason why you should not exhibit these papers to defendant's counsel here present except the resolution that has been adopted by the several counsel for the complainant that such inspection shall not be granted?

A. I have not considered this matter, and if I had I would not care to express my personal opinions about it. Mr. Lowrey has charge, as counsel for the complainant, as I understand it, of this branch of the case, and the course that has been taken, so far as I am con-
11064 cerned, is the result of his advice.

18 Q. Then I suppose it would be useless for defendant's counsel to ask you to exhibit these papers to them for inspection?

A. It would be, quite so. In delivering these papers to Mr. Hastings I feel that I have complied with the suggestion of Lord Mansfield, which is quoted with approval in the opinion of Judge Lacombe in this case dated, October 18, 1890.

RICHARD N. DYER.

11065

SHERBURNE B. EATON, a witness in behalf of complainant, having already been sworn in this case, testified as follows, in response to questions by Mr. Lowrey:

1 Q. Mr. Herrick was asked some questions in respect to who had represented him as counsel in the proceedings resulting from his failure to produce, in obedience to a subpœna *duces tecum*, certain papers—(his answer may be referred to by you if you do not remember the facts.) I would be glad to have you
state the facts, as far as you know, upon the subject of 11066
the representation of Mr. Hastings and Mr. Herrick, if any?

A. Mr. Herrick is president of the Edison Electric Light Company, the complainant in this suit. I am the General Counsel of that company. In our respective official capacities we have talked about the production of these papers; also about the subpœna *duces tecum*, and the order of Judge Lacombe of the 5th inst. In all of these talks I have always supposed
that we were both acting officially, and not otherwise. 11067
If Mr. Herrick intended, by anything which he ever said in this matter, to have me, or anybody recommended by me, represent him as personal counsel, I certainly failed to understand it. I have never represented him as personal counsel in any manner whatsoever, nor have I ever procured anybody else to do so, and I have never understood that he asked me to do either of these two things.

2 Q. Did you ask Mr. Lowrey, at any time, to represent Mr. Herrick in any manner?

A. No, sir. 11068

3 Q. Or to represent Mr. Hastings?

A. No. sir.

Cross-examination of Mr. Eaton by MR. DUNCAN:

4 x-Q. I show you copies of two letters, dated respectively November 10th, 1890, and November 12th,

11069 1890, signed by Eaton & Lewis, and ask whether those letters emanated from your office?

A. They did, and were signed by me personally, in my firm name.

5 x-Q. In what capacity were you acting when you wrote the letter of November 10th, 1890?

A. Technically speaking, in the capacity of attorneys of record in this case; practically speaking, as general counsel of the plaintiff in this case.

11070 Defendant's counsel offers in evidence copies of the two letters above referred to, and the same are marked "Defendant's Exhibit Eaton & Lewis Letter of November 10th, 1890," and "Defendant's Exhibit Eaton & Lewis Letter of November 12th, 1890."

It is stipulated by the plaintiff's counsel, that these copies may be used with the same force and effect as the originals might be used.

11071 Defendant's counsel also offers in evidence copies of two letters written by Kerr & Curtis on the 8th and 11th days of November, 1890, respectively, addressed to Messrs. Eaton & Lewis, the said letters being the two letters to which the exhibits Eaton & Lewis Letter, of November 10th, and Eaton & Lewis Letter of November 12th, 1890, are in reply, and the said exhibits are now marked "Defendant's Exhibit Kerr & Curtis Letter of November

11072 8th, 1890," and Defendant's Exhibit Kerr & Curtis Letter of November 11th, 1890."

6 x-Q. Please state whether you received the two letters of Kerr & Curtis, bearing date November 8th, and November 11th, respectively?

A. I did. And in replying to them I presumed that what you were really after was, not the body of Mr. Herrick, or that of Mr. Hastings, but the papers, and my answers were framed to expedite the matter.

S. B. Eaton.

Mr. Lowrey having already announced his purpose, acting as counsel for the complainant, to deposit with the Examiner, under seal, the papers in question, to be held by him subject to the further order of the Court on the question whether defendant's counsel ought to be permitted to examine the same; and Mr. Duncan of counsel for defendant having announced that if such papers are placed in the hands of the Examiner he will 11074 immediately, and before any such further order, demand and claim from the Examiner the opportunity to examine the same, Mr. Lowrey now requests the Examiner to seal up the paper box or file now handed to him for that purpose, putting upon them his own mark for security against opening thereof, and return the same to Mr. Lowrey. 11073

Defendant's counsel states that if the papers in question are handed to the Examiner 11075 he will demand of the Examiner inspection of the same.

Defendant's counsel also states that some papers having been handed to the Examiner, that he now makes demand upon the Examiner for the inspection of these papers before the same are sealed up.

The Examiner says that, as the papers are 11076 not offered in evidence, but are simply placed in his hands to be sealed up, he cannot place them in the hands of defendant's counsel.

Defendant's counsel requests the Examiner to certify the record to the Court.

11077

Defendant's Exhibit Kerr & Curtis Letter of Nov. 8, 1890.

New York, November 8th, 1890.

Messrs. Eaton & Lewis,
120 Broadway, New York.

Dear Sirs:—We have had copies of Judge Lacombe's order of November 5, in Equity suit No. 3,445 of which we sent you copy on the 6th, served upon
11078 Messrs. Herrick and Hastings, and we assume that they will wish to produce the papers in obedience to the order within the ten days fixed by it. If you will ascertain from them, and inform us what day and hour will suit their convenience we will have the Examiner in attendance at Gen. Duncan's office. We suggest this merely for the purpose of avoiding any unnecessary inconvenience to Messrs. Herrick and Hastings, and to facilitate the proceedings.

11079 Yours very truly,

Kerr & Curtis.

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Defendant's Exhibit, Eaton & Lewis Letter of Nov. 10, 1890.

New York, Nov. 10, 1890.

Messrs. Kerr & Curtis:

Gentlemen:—Equity suit No. 3,445. Replying to your valued favor of this date, we beg to say that we have not yet decided whether to advise Messrs. Herrick and Hastings to produce the papers or not. No
doubt we shall decide before the expiration of the ten 11082
days, although the absence from the city of both Mr. Seward and Mr. Dyer may cause delay. If we decide not to produce the papers we shall try to put the matter into shape so as to have all the questions argued at one hearing, touching the production of these papers as suggested by Judge Lacombe.

You speak at the end of your letter about our avoiding any unnecessary inconvenience to Messrs. Herrick and Hastings. We do not imagine that you really
purpose to attach them. Our view of the matter is, 11083
that these preliminary steps are only to get matters into proper shape for final argument before the Court, if we decide not to produce the papers. If, however, you wish them attached, please notify us and we shall produce them in person.

We repeat that we hope to be able to give you our final answer in this matter before the expiration of the ten days, but if, owing to the absence of counsel, we have to ask for an extension of time, we shall do so in
due season. 11084

Yours very truly,

Eaton & Lewis.

11085

Defendant's Exhibit Kerr & Curtis Letter, of Nov. 11, 1890.

November 11, 1890.

Messrs. Eaton & Lewis,
120 Broadway, City.

GENTLEMEN :—Your favor of yesterday, in regard to equity suit No. 3,445, has been received. We understand that the proper mode of producing the papers,
11086 in case you decide to advise their production, is by attendance of the witnesses and production of the papers before the Examiner, as required by the subpœnas to which the order refers, and we do not feel authorized to consent to any departure from the terms of the order in this respect.

Our suggestion in regard to avoiding inconvenience to Messrs. Herrick and Hastings was intended to refer merely to the selection of a time convenient for them for attendance before the Examiner. If you have un-
11087 derstood it in a different sense, we wish to say that while we have no desire to annoy Messrs. Herrick and Hastings or to put them to any inconvenience, we understand that we are entitled to the papers, and shall not feel disposed to waive any remedy accorded to us by the Court for their production. We assume, however, that as these gentlemen are acting under your advice, they will not take any course which will make an attachment necessary or proper, and we have no desire to resort to any such remedy if it can be
11088 avoided.

Are we to understand that you appear for Messrs. Herrick and Hastings in this matter?

Yours very truly,
KERR & CURTIS.

Defendant's Exhibit Eaton & Lewis Letter of Nov. 12, 1890. 11089

NEW YORK, Nov. 12, 1890.

Messrs. Kerr & Curtis :

GENTLEMEN :—Re Edison Filament Suit, being Equity Suit No. 3,445. Your valued favor of yesterday is at hand. We have not yet decided whether to produce the papers or not, but shall de-
cide before the return day, Saturday next. We do 11090
not appear for Messrs. Herrick and Hastings, but you can assume that either we or some other counsel will appear for them whenever you send us word that you would like to have them produced anywhere in person pursuant to the order of the Court.

Very truly yours,
EATON & LEWIS.

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11093 **Defendant's Exhibit Judge Lacombe's Decision of January 5, 1891.**

S. M. H., Ex.

CIRCUIT COURT OF U. S.

SOUTHERN DISTRICT OF N. Y.

EDISON ELECTRIC LIGHT CO.

vs.

11094 U. S. ELECTRIC LIGHTING CO.

For the Complainant: Messrs. C. A. SEWARD and GROSVENOR LOWREY.

I. The case does not require or justify enforced disclosures of private papers.

Story *v.* Lennox, 1 Keene, 349–350.
11095 Bischoffsheim *v.* Brown, 24 Blatchf., 174.
Bispham's Equity, 4th Edn., Sections 559, 561.
Marie *v.* Garrison, N. Y. Daily Reg., April 25, 1884.
2 Dan. Ch., p. 1818.
Wharton on Evidence, Section 754.
Bolton *v.* Corporation of Liverpool, 1 Mylne & Keene, 88.
Pomeroy Eq. Jur., Section 201.
11096 Peile on Discovery, 33–41.
Benbow *v.* Low, 16 Ch. D., 93, L. R.
Hoyt *v.* American Exch. B'k., 1 Duer, 656.

II. Sufficient grounds have not been laid to entitle defendant to inspection.

Leggett *v.* Postley, 2 Paige Ch., 599.
Scott *v.* Walker, 2 Ellis & Blackburn, 562.
U. S. *v.* Boyd, 116 U. S.
Cousins *v.* Smith, 15 Ves., 542.
Waddeer *v.* East India Co., 35 E. L. & Eq., 283.
Wally *v.* Duke of Portland, 3 Ves., 494.

III. Discovery would be contrary to public policy. 11097

Waddeer *v.* East India Co., 35 E. L. & Eq., 283.
Cooley Constitutional Limitations, 6th Ed., p. 371.
U. S. *ex rel.* U. S. El. Lighting Co. *v.* Commissioner of Patents, Sup. Court Dist. of Columbia, June 23, 1890 (MS.)

IV. Inspection of one document will make the entire series evidence. 11098

Jordan *v.* Wilkins, 2 Wash. C. C. R., 482.
Walter *v.* Stewart, 4 Cranch C. C. R., 532.
Lawrence *v.* Van Horne, 1 Caines, 285.
1 Thompson on Trials, Section 829.
1 Wharton on Evidence, Section 156.
Stephens' Dig. of Ev., Chase's Notes, 240.
Taylor on Evidence, Section 1614.
Calvert *v.* Flower, 7 C. & P., 386.
Wilson *v.* Bowie, 1 C. & P. S. 11099
Richards *v.* Frankham, 9 C. & P., 221.
Penobscot *v.* Samson, 4 Shepley, 224.
Randall *v.* Chesapeake, 1 Harrington, 223.
Ellison *v.* Conser, 40 N. J. Law, 444–5.
Commonwealth *v.* Davidson, 1 Cush., 45.
Pennell *v.* Meyer, 8 C. & L., 470.

For the Defendant: Messrs. E. WETMORE and S. A. DUNCAN cited: 11100

Greenleaf on Evidence, Section 293.
Wharton on Evidence, Section 954.
Giant Powder Co. *v.* California Company, 4 Fed. Rep., 720.
Chicago *v.* Sheldon, 9 Wall., 50.
U. S. Rev. Stat., Sections 858, 892.
Starkie on Evidence, 9th Ed., 113.
Mitchell's Case, 12 Abb. Pr., 249.
Blease *v.* Carlington, 2 Otto, 1.
Bischoffsheim *v.* Brown, 29 Fed. Rep., 743.

11101 LACOMBE, Circuit Judge:

This case now comes before the Court upon an objection certified by the Examiner. It is unnecessary to recite the facts already set forth in the decision of October 18th, and memorandum of November 24th. Subsequently thereto, both parties being before the Examiner, the defendant's counsel demanded that complainant produce, for the examination of defendant's counsel and for use as evidence if defendant
11102 be so advised, the full text of the divisional application made by Thomas A. Edison, December 15th, 1880, being one of the papers covered by the *subpoena duces tecum* heretofore served upon the officers of the company. The paper being placed in the Examiner's hands, complainant's counsel object to its being handed to or inspected by defendant's counsel upon three grounds:

(1.) Because the production and delivery of the papers for the purpose specified cannot lawfully be
11103 compelled.

(2.) Unless defendant's counsel will set forth that he intends to offer the papers in evidence when produced.

(3.) Unless defendant's counsel will also set forth that he intends to offer in evidence *all* the other papers connected with the said application.

The particular paper is not the original divisional application, but it has been proved to be a copy
11104 thereof by complainant's own witness, and is competent as secondary evidence if the case would warrant the production and admission of the original. The copy bears various pencil memoranda, apparently not on the original, indicating changes for subsequent amendments. They were made by counsel and would, for that reason, be privileged were it not that it appears from examination of the other papers in the box that they have all been communicated to the patent office, and are therefore no longer solely communications between counsel and client.

The various objections now urged have been 11105
already passed upon. Inasmuch, however, as complainant's counsel insist that an adverse decision will seriously affect, not this case only, but also what they claim to be well-settled rules of evidence in similar cases, careful consideration has been given to their exhaustive brief, and the entire subject re-examined. The conclusion heretofore reached remains unchanged.

The authorities cited by the complainant do not 11106
go to the extent of holding that it is only by bill of discovery, or similar method, that some particular piece of documentary evidence is to be obtained. No doubt when it is brought into court the objection, that "it is against conscience and the spirit "of Anglo-Saxon laws and liberty" to permit its inspection by the other side, or its introduction in evidence, may be urged as it has been in this case, before the document is exhibited to any one but the Court. But that the process of *subpoena duces* 11107
tecum is a convenient, efficient and proper method for bringing the paper into court is beyond dispute in this circuit.

Bischoffsheim *v.* Brown, 29 Fed. Rep., 743.

The fundamental difficulty with the complainant's argument arises from an apparent misconception of the precise point raised under the subpoena; a misconception no doubt promoted and encouraged by the singular persistency with which the defendant's counsel have sought to obtain not merely the 11108
document itself, but permission to have a copy of it made for their own use. The subpoena (so far as the present objection is concerned) is specific. In this respect the case at bar differs from those cited by complainant's counsel.

The defendant is not "claiming the right to a general inquisitorial examination of all the books, "papers and documents of his adversary, with the "view to ascertain if perchance something may be "found which will possibly aid it," nor is it asking "before the hearing to pry into the case of its

11109 "adversary," nor "to see in advance of the trial "evidence which the other side are going to produce," nor "calling upon its adversary to exhibit "for inspection anything and everything in writing "under the latter's control, which may assist the "defendant," nor is this an "unnecessary inquisition "into the contents of private papers by one who "has no interest in them." No "complete disclosure of everything the complainant knows or believes in relation to the matter in question" is
11110 sought for, nor is this a "general fishing excursion." A particular document, whose existence is well-known to both parties, and, in fact, to the general public is specifically called for. It is described with a fullness (by date, description and serial number) which leaves no doubt as to its identity. No doubt it is in the complainant's possession, but the authorities do not go to the length of holding that the mere circumstance of
11111 possession by his adversary will preclude a party from bringing into court and putting in evidence a document which may damage that adversary's case, but which he is able himself to identify and call for, without invoking the aid of his adversary's conscience, by means of a bill of discovery.

Nor, if the document called for contains what the defendant insists it does, would it be any part of his adversary's case, nor within the rule as to
11112 title deeds laid down in some of the cases cited. It would be a separate document, containing admissions material to defendant's case. "A party "can be compelled to disclose all facts which "would, by way of evidence, tend to *impeach* or *de*-"*stroy* his case, unless otherwise privileged, since "such facts are material evidence for his adversary, "but is not bound to disclose any evidence by "which he intends to or may *support* his case, "for such evidence cannot be material to his adversary."

Pomeroy Eq. Jur., Section 201.

The objection that the application is privileged 11113
upon grounds of public policy, because it is an application pending in the Patent Office, was considered when this case was up on the motion to compel obedience to the subpoena. The opinion of the Supreme Court of the District of Columbia was at that time considered, and also the quotation from Cooley's Constitutional Limitations as to communications made to a telegraph operator. The latter citation refers
to a case not analogous to this, for surely no one 11114
contends that a party who has sent a telegraphic message may not in a proper case be himself interrogated as to its contents and required to produce a copy if he has one, although the operator may not be allowed to disclose it.

To the memorandum filed upon the decision of the prior motion, there is nothing to add. Regulations as to what classes of *quasi*-public documents shall or shall not be privileged may appropriately be made
by the legislative branch of the government, which 11115
passes the statutes under the operation of which those very documents are created. Whether, when it has failed to make any such provisions, it may be desirable for the courts to do so, is not the question presented here, because in this case there has been no such failure. Congress, in the very statute which required inventors to file applications in the Patent Office, expressly provided that *all applications interfering with caveats* should be deposited
in the confidential archives, and be, therefore, privi- 11116
leged (Rev. Stat., Section 4,902). If all applications were thus privileged, this provision would have been unnecessary, and the fact of its enactment seems to indicate quite clearly that Congress, having the whole subject under advisement, determined that it would extend the privilege to the particular class of aplications therein specified, and inferentially only to them.

The subject having been thus regulated, and the question of "public policy" determined by those to whom such regulation and determination more appropriately belong, further investigation thereof by the courts seems to be uncalled for.

11117 The objection to the materiality of the document called for was considered generally on the former motion. It has now been inspected by the Court, and as the result of such inspection it is enough to say that it is sufficiently germane to the issues raised in this case to warrant its offer in proof so that it may form part of the record (either as admitted or excluded evidence) which is to go to the Supreme Court.

11118 *Blease* v. *Garlington*, 2 Otto, 1.

If offered, therefore, it will be admitted, but the objection to such admission will be reserved for disposition upon final hearing by the judge whose familiarity with the whole case will enable him to render an intelligent decision.

The defendant is asking for leave to inspect the document before offering it in evidence. As to the effect of inspection the contention of the complainant is sustained by the authorities. If a party in-
11119 spect a document produced by his adversary in response to a *subpoena duces tecum* issued by him, such document may be admitted as evidence for his adversary, if he himself declines to put it in.

Jordan *v.* Wilkins, 2 Wash. C. C. R., 482.
Walter *v.* Stewart, 4 Cranch C. C. R., 532.

As counsel for both sides seem to be agreed upon the point, that exhibition of the fundamental document (the application) carries exhibition of the other
11120 papers, viz.: the correspondence between the Patent Office and the Edison Company in relation to said application, the same disposition will be made as to each one of them when separately called for.

January 5th, 1891.

E. Henry Lacombe.

Endorsed—Circuit Court of the United States for the Southern District of New York—Edison Electric Light Company vs. United States Electric Lighting Company—Decision, Lacombe, J.—U. S. Circuit Court, Filed Jan. 5, 1891, John A. Shields, Clerk.

Defendants' Exhibit, Judge Lacombe's Order of January 12, 1891. 11121

S. M. H.,
Ex'r. and Clerk.

At a stated term of the Circuit Court of the United States for the second circuit and Southern District of New York, held in the United States Court House, in the City of 11122
New York, on the 12th day of January, 1891.

Present—Lacombe, Circuit Judge.

The Edison Electric Light Company
vs. In Equity. No. 3445. 11123
The U. S. Electric Lighting Company.

This cause having come on for hearing on the 25th day of November, 1890, on the objections raised of record by complainant's counsel to the production, "for the examination of defendant's counsel, and "for use as evidence herein if defendant be so ad-
"vised," of the papers constituting a certain appli- 11124
cation for letters patent filed in the Patent Office of the United States by Thomas A. Edison, on the 15th day of December, 1880—the grounds of said objections being:

"(1) That such production for the specified purpose cannot be lawfully compelled, "nor can the delivery of the papers specified be lawfully compelled for the use of "the defendant as above stated."

11125 "(2) Unless the defendant's counsel will "state upon the record that they intend to "offer in evidence each of the said papers "when so produced."

"(3) Unless the defendant's counsel will "state upon the record that it is the intention of the defendant to offer in evidence "all of the papers * * * * * part and "parcel of the proceedings in the Patent "Office connected with such application;"

11126 and on the motion entered on the record by complainant's counsel on November 25, 1890, "for a "decision upon the objections above raised, and for "a judgment that no sufficient ground has been "laid by the defendant to entitle it to the examination and inspection of said documents, and for "judgment that the said documents are privileged "from such examination and inspection as being "copies of documents protected by public policy "from such examination in the Patent Office, and
11127 "for an order directing the redelivery of the same "by the examiner to the complainant's solicitor;"

And the questions involved in the said motion having been fully argued, orally and in printed briefs—Messrs. C. A. Seward and G. P. Lowrey appearing and being heard for the complainant, and Messrs E. Wetmore and S. A. Duncan appearing and being heard for the defendant;

And the Court having fully considered the
11128 premises, and it appearing to the Court that the said papers are not privileged as being communications between counsel and client, or upon grounds of public policy as being a copy of an application pending in the Patent Office; and it appearing further, as to the materiality of the said papers, that they are sufficiently germane to the issues raised in this case to warrant their offer in proof so that they may form part of the record (either as admitted or excluded evidence) which is to go to the Supreme Court:

Now, therefore, it is hereby ordered that the 11129
complainant's objections to the exhibition of the said papers be and hereby are overruled, and that complainant's said motion be and hereby is denied, and the examiner is directed to exhibit the said papers to defendant's counsel, upon their demand therefor, with view to the same being offered in evidence; and in case the said papers are offered in evidence, they will be admitted, any objection to their admission being hereby re-
served for disposition upon the final hearing of 11130
the cause.

A like order to the examiner, with the same conditions, is made with reference to each and all of the other papers constituting the correspondence between the Patent Office and the said Thomas A. Edison or his assignee, the plaintiff herein, in relation to the said application.

O. K. E. Henry Lacombe.
Eaton & Lewis. 11131

S. A. Duncan,
Edmund Wetmore,
For Deft.

11132

11133

UNITED STATES CIRCUIT COURT,

SOUTHERN DISTRICT OF NEW YORK.

THE EDISON ELECTRIC LIGHT COMPANY AGAINST THE UNITED STATES ELECTRIC LIGHTING COMPANY.	In Equity. 3445.

11134

NEW YORK, January 12, 1891.

Met pursuant to notice, at the office of Mr. C. A. Seward.

11135 Present—Messrs. CLARENCE A. SEWARD, and R. N. DYER, of counsel for complainant. Messrs. SAMUEL A. DUNCAN and EDMUND WETMORE, of counsel for defendant.

The examiner states that, pursuant to the order of this Court of this date, he produces the papers marked for identification on November 25th, 1890, together with the

11136 papers contained in the box sealed by him November 15, 1890, which he believes to be all of the papers called for in said order.

Defendant's counsel calls upon the examiner to exhibit, pursuant to the provisions of the order of the Court this day made in the premises, the specification, claims and drawing forming a part of the divisional application for letters patent filed by Thomas A. Edison in the Patent Office of the United

States on December 15, 1880; together with the papers constituting the correspondence in relation to the said application between the Patent Office and the said Edison, or his assignee, the plaintiff herein. 11137

The examiner complies with the request of defendant's counsel, by submitting to him the papers in the examiner's possession, which the examiner believes to be all of the papers included in the request of defendant's 11138 counsel.

Further hearing adjourned to January 13, at 12 m.

NEW YORK, January 13th, 1891.

Met pursuant to adjournment.

11139

Present—Counsel as before.

Adjourned to January 14, 1891.

NEW YORK, January 14th, 1891.

Met pursuant to adjournment.

Present—Counsel as before.

It is stipulated by the counsel for the complainant, that the papers produced by the examiner as constituting the divisional application of Mr. Edison, of December 15, 1880, and the correspondence connected therewith, consist, severally, of the following: 11140

11141

(1.) The paper marked "No 1, S. M. H.," (omitting the pencil interlineations and marginal annotations on the same) is a copy of the specification and the claims of the divisional application for letters patent filed in the Patent Office of the United States, on the 15th day of December, 1880, by Thomas Alva Edison, the same being a
11142 division of the earlier application (known
as Edison's case No. 187) filed by the said Edison in the Patent Office on the 11th of December, 1879.

The pencil interlineations and marginal annotations on the above paper relate to amendments made in the said specification and claims at dates subsequent to the filing of said application of December 15, 1880.

11143 (1½.) The paper marked "No. 1½, S. M.
H.," is a copy of the drawing which is referred to in the foregoing specification, and which formed a part of the aforesaid application.

(2.) The paper marked "No. 2, S. M. H." is a copy of a letter which accompanied the aforesaid application when filed.

(3.) The paper marked "No. 3, S. M. H."
11144 is an original letter from the Patent Office
under date of February 10, 1881; being an action on the aforesaid application.

(4.) The paper marked "No. 4, S. M. H." is a copy of the body of a letter sent to the Patent Office under date of April 3, 1882, by the attorney of Mr. Edison then in charge of the aforesaid application.

11145

(5.) The paper marked "No. 5, S. M. H." is an original communication from the Patent Office, under date of April 10, 1882, in relation to the aforesaid application.

(6.) The paper marked "No. 6, S. M. H." is the body of a communication sent to the Patent Office, under date of May 16, 1882, by the attorney of Mr. Edison then in
charge of the aforesaid application. 11146

(7.) The paper marked "No. 7, S. M. H." is a copy of a letter of amendment sent to the Patent Office, under date of May 23, 1882, by the attorney of Mr. Edison then in charge of the application.

(8.) The paper marked "No. 8, S. M. H." is an original communication from the Patent Office, under date of June 1, 1882,
in relation to the aforesaid application. 11147

(9.) The paper marked "No. 9, S. M. H." is a copy of a letter, written under date of June 11, 1882, by the attorney in charge of the application to R. N. Dyer, Esq., at Menlo Park, New Jersey.

(10.) The paper marked "No. 10, S. M. H." is a copy of the title and body of the affidavit referred to in the aforesaid paper
marked "No. 9." 11148

(11.) The paper marked "No. 11, S. M. H." is a copy of a communication sent to the Patent Office, under date of June 12, 1882, by the attorney of Mr. Edison, then in charge of the aforesaid application.

(12.) The paper marked "No. 12, S. M.
H." is an original communication from the
Patent Office, under date of July 3, 1882,
relating to the aforesaid application.

(13.) The paper marked "No. 13, S. M.
H.," is a copy of a communication sent to
the Patent Office under date of July 28,
1882, by the attorney of Mr. Edison, then
11150 in charge of the aforesaid application.

(14.) The paper marked "No. 14, S. M.
H.," is a copy of a communication sent to
the Patent Office under date of August 19,
1882, by the attorney of Mr. Edison, then
in charge of the aforesaid application.

(15.) The paper marked "No. 15, S. M.
H.," is a copy of a communication sent to
the Patent Office under date of August 23,
11151 1882, by the attorney of Mr. Edison, then
in charge of the aforesaid application.

(16.) The paper marked "No. 16, S. M.
H.," is a copy of a communication (embodying a substitute specification and
claims) sent to the Patent Office on the 13th
of January, 1883, by the attorney of Mr.
Edison, then in charge of the aforesaid application.

11152

(17.) The paper marked "No. 17, S. M.
H.," is a copy of the body of an affidavit
made by Mr. Edison on the 13th day of
January, 1883, and sent to the Patent Office
in connection with the substitute specification and claims embodied in the last named
paper, viz.: "No. 16, S. M. H."

(18.) The paper marked No. 18, S. M.
H." is an original communication from the
Patent Office, under date of March 13, 1883,
in relation to the aforesaid application.

(19.) The paper marked "No. 19, S. M.
H." is a copy of an appeal to the Examiners-in-Chief from the decision of the principal examiner in relation to the above-
named application, sent to the Patent Of- 11154
fice June 2, 1883, by the attorney of Mr.
Edison then in charge of the aforesaid application.

(20.) The paper marked "No. 20, S. M.
H." is an original communication from the
Patent Office, under date of July 6, 1883,
in relation to the aforesaid application.

(21.) The paper marked "No. 21, S. M.
H." is a copy of a communication sent to 11155
the Patent Office under date of July 11,
1883, by the attorney of Mr. Edison then in
charge of the aforesaid application, withdrawing the appeal embodied in the aforesaid paper marked "No. 19, S. M. H."

(22.) The paper marked "No. 22, S. M.
H," is an original communication from the
Patent Office, under date of August 10,
1883, in relation to the aforesaid applica- 11156
tion.

(23.) The paper marked "No. 23, S. M.
H," is a copy of a communication sent to
the Patent Office, under date of October 12,
1883, by the attorney of Mr. Edison, then
in charge of the aforesaid application.

11157 (24.) The paper marked "No. 24, S. M. H," is an original communication from the Patent Office, under date of October 15, 1883, in relation to the aforesaid application.

(25.) The paper marked "No. 25, S. M. H," is a copy of a communication sent to the Patent Office, under date of December
11158 12, 1884, by the attorney for Mr. Edison, then in charge of the aforesaid application; the document appended to the said communication, being a copy of an affidavit made by Mr. Edison on or about the 12th day of December, 1884, and sent to the Patent Office to accompany the aforesaid communication of December 12, 1884.

(26.) The paper marked "No. 26, S. M. H." is an original communication from the
11159 Patent Office, under date of December 20, 1884, in relation to the aforesaid application.

(27.) The paper marked "No. 27, S. M. H." is a copy of a communication sent to the Patent Office, under date of December 18, 1886, by the attorney for Mr. Edison, then in charge of the aforesaid application.

11160 (28.) The paper marked "No. 28, S. M. H." is an original communication from the Patent Office, under date of January 27, 1887.

(29.) The paper marked "No. 29, S. M. H." (leaving out the pencil interlineations in said paper) is a copy of a communication sent to the Patent Office, under date of January 29, 1887, by the attorney of Mr. Edi-

son, then in charge of the aforesaid application; the said communication embodying a substitute specification and claims. 11161

(30.) The paper marked "No. 30, S. M. H." is an original communication from the Patent Office, under date of February 23, 1887, in relation to the aforesaid application.

(31.) The paper marked "No. 31, S. M. 11162
H." is a copy of a communication sent to the Patent Office, under date of February 21, 1889, by the attorney for Mr. Edison in charge of the aforesaid application.

(32.) The paper marked "No. 32, S. M. H." is an original communication from the Patent Office, under date of March 12, 1889, in relation to the aforesaid application.

(33.) The paper marked "No. 33, S. M. 11163
H." is a copy of the body of a communication to the Commissioner of Patents under date of April 30, 1890.

It is further stipulated that the "copies" which constitute a part of the foregoing papers are the copies that were retained by the attorneys at the times when the originals were sent to the Patent Office.

Complainant's counsel, Mr. Dyer, states
that he has examined the various papers 11164
above named, marked "No. 1, S. M. H." to "No. 33, S. M. H.," inclusive, and finds them to be the same which he testified about on the 25th day of November, 1890, as constituting the divisional application of Thomas A. Edison of December 15, 1880, and the correspondence with the Patent Office relating thereto; also, that he believes that these papers show the entire proceedings in connection with the prosecution of the said application.

11165

Defendant's counsel offers in evidence those of the papers mentioned in the foregoing stipulation, which are numbered as follows: No. 1, No. 1½, No. 2, No. 4, No. 6, No. 7, No. 11, No. 13, No. 14, No. 15, No. 16, No. 17, No. 19, No. 21, No. 23, No. 25, No. 27, No. 29, No. 31, No. 33.

The plaintiff's counsel object to the in-
11166 troduction in evidence of each and every of
the foregoing papers upon the following
grounds :

First: The defendants having called said Edison as a witness and interrogated him as to the contents of said papers or some of them are estopped from discrediting him by offering such papers as a contradiction of his evidence.

11167 *Second:* The defendants having applied to
the Supreme Court of the District of Colum-
bia, as appears by Volume 54 of the Official
Gazette, page 267, for a mandamus to compel
the Commissioner of Patents to produce the
originals of the papers now offered in evi-
dence, or copies thereof, for use by them as
evidence in this case, and the said Supreme
Court having denied the said application, as
appears by said Official Gazette, and the de-
11168 fendants having had their day in court there-
on, were estopped from applying to this Court
or from issuing a subpoena to compel the pro-
duction by the plaintiff of the papers now of-
fered in evidence, and this Court was without
lawful jurisdiction to make an order in effect
reversing said decision of the Supreme Court
and compelling the plaintiff to produce the
papers now offered.

11169

Third: The said papers were and are confidential and privileged communications between the said Edison and his solicitors.

Fourth: The said papers were privileged communications between the said Edison and the officers of the United States Patent Office.

Fifth: The acts and declarations of the said
Edison and his solicitor after the issuance of 11170
the patent in suit and its transfer to the plain-
tiffs are not competent evidence to affect the
right of the plaintiffs under such transfer and
patent.

Sixth: Said papers are severally irrelevant, incompetent, immaterial and inadmissible.

Seventh: The plaintiffs are not privy to
said papers or any of them, or legally to be
affected thereby, or by the contents of any 11171
thereof.

Eighth: That said papers are fragmentary and incomplete, and contain a portion only of the papers produced under the order of the Court and in obedience to the subpoena; and that the defendant ought of right, if any of the papers are put in evidence, to put in evidence all of the papers so produced.

Ninth: It appearing from the said papers 11172
that the application for the patent with which
they were connected has been rejected by the
Patent Office, said papers are incompetent
and irrelevant as evidence to affect the rights
of the plaintiff in any way.

11173 Plaintiff's counsel thereupon offer in evidence, and as a part of defendant's evidence, the following papers referred to in said stipulation, which were produced under the order of the Court and subpœna, and submitted to defendant's counsel, and constitute a portion of the papers on file in the Patent Office and in the hands of the solicitors of said Edison and connected with the said application, and
11174 which papers it is stipulated may be printed in the record in the appropriate chronological position with reference to the papers so offered by the defendant.

The numbers of said papers with reference to the foregoing stipulation identifying said papers are as follows: Nos. 3, 5, 8, 9, 10, 12, 18, 20, 22, 24, 26, 28, 30, 32.

Defendant's counsel objects to the offer by
11175 the plaintiff of the foregoing papers "as a part of the defendant's evidence;" also on the ground that the said papers are incompetent, irrelevant, immaterial and inadmissible.

Defendant's counsel offers in evidence a copy of the decision of Judge Lacombe, rendered January 5th, 1891, and the same is marked "Defendant's Exhibit, Judge Lacombe's Decision of January 5, 1891."

Adjourned, subject to notice.

11176

EDISON'S DIVISIONAL APPLICATION of DEC. 15, 1880. 11177

Defendant's Exhibit, "Edison's Divisional Application, No. 1."

S. M. H., Ex.

[*Original Specification; Dec. 15, 1880.*]

The object of this invention is to
cent 11178
produce an incandescing electric lamp
which shall render practicable a system
of electric lighting, wherein a great
number of lamps may be used, fed
by current generated at and distributed
from one source located at what may
be termed a central station.

Many attempts have been made to
produce a practical electric lamp
by causing an electric current to heat 11179
to incandescence a suitable conductor
attempted
in an ^ vacuum, or in an atmosphere of an
or non-combustion supporting
non-azotic ^ gas, but no practically
d
operative lamp has yet been devised.
therefor before the date of my work upon
this subject

For such lamps it is now uni-
versally known that carbon is the 11180
preferable material for the incandescing
conductor.

Such carbons, in the attempts hith-
erto made, have been of comparatively
low resistence, ordinarily from two
to four ohms, never exceeding five
ohms, so far as can be ascertained

N. B.—The matter above printed in brevier is *interlined in pencil* in the original.

Also, in the original the term "a non-azotic," in lines 13 & 14, is changed in pencil to "an azotic," and the words "has yet," in line 15, is changed in pencil to "Ird."

11181 from the records of the art, being quite
thick and bulky relatively to their
length.

It has been customary to treat
carbon for such use in order to
lessen its resistance, that is to take
a pencil of carbon, and increase its
density and conductivity by the filling
up of its pores with other carbons, for
instance by the deposition caused by
11182 electrical incandescence due to a cur-
rent traversing such carbon while im-
mersed in a hydro-carbon vapor or
liquid, or by soaking the carbon in a
syrup or other liquid rich in carbon
and then re-carbonizing. In fact
the practice universally has been to
reduce the natural resistance of the
carbon, bringing it to a relatively very
low point.

11183 This, from its attendant circumstances
has been the main cause of failure
of the attempts at incandescent electric
rationale
lighting, the rationals of which may be
briefly sketched as follows—

It is essential in incandescent
lamps that every trace of free or
combined oxygen, so far as possible,
11184 should be removed from the enclosing
globe, in order to prevent the dis-
integration or consumption of the
carbon due to its being in contact with
air. With the means employed by
me it is possible to attain a
sufficiently high degree of vacuum to
attain this were no air occluded in
the carbon itself or were it fully
carbonized. Air, or other gases

and watery vapor and also hydro- 11185
carbon not decomposed in the original
carbonization, containing oxygen enough
for the impairment of the carbon, are
however contained therein, and the car-
bon must be treated in some manner
to ensure freedom from this danger,
and processes therefor have been devised.

A carbon of low resistance how-
ever means bulk, so much bulk that
no process has yet been devised which 11186
will remove entirely and in a com-
mercially practical manner the oc-
cluded air, or gas, or vapor, or hy-
dro-carbon from such a carbon, the
result being that from the carbon it-
self finally were freed, under the
influence of heat, the agencies which
ultimately caused its destruction.

As the greatest portion of the re-
sistance in an electric circuit, to pro- 11187
duce light at some point in the cir-
cuit, must be concentrated at that
point, a low resistance carbon necessi-
tated the use of conductors thereto of
very small resistance which meant such
bulk of conductor that, owing to the
different co-efficients of expansion of the
conductor and glass under heat, it
was impracticable to seal the conductors
in the glass itself. In all attempts 11188
hitherto made, the glass globe was
therefore sealed by a foreign substance, some-
times metal caps with composition there-
over, sometimes combinations of cements,
gums, paraffin, etc. were used. When
it was attempted to produce a stable

11189 vacum (which attempt was seldom made)
air inevitably penetrated through such
a seal destroying the lamp. When
an artificial atmosphere was used it
has been found practically impossible
to maintain perfect joints under the
varying degrees of heat and pressure,
because the expansion of the of the ar-
-tificial atmosphere due to the heat of
the luminous conductor expels a portion
11190 of the same through any such sealing,
which is replaced, upon contraction by
cooling, by external air.

cs
The large mass ^ of conductor
necessary to these low resistance carbons
were the means necessarily of conveying
large amounts of heat, endangering the
glass case and the sealing thereof, so
that it became necessary to interpose
11191 non-conducting plates and to so con-
-struct the conductors, making by twists
and convolutions, a great length thereof
in the lamp, so as to prevent the
heat reaching the glass and seal.
Such experiments could not prevent
only defer the effect for a time, and
hence were unavailing.

The necessary difference in the re-
11192 sistance of the incandescing conductor
and the conductors supplying the same
before noted, necessitated, in any at-
tempt at a system, the use of con-
ductors of exceedingly low resistance,
which could only be obtained by the
use of a great mass of material.
This involved the expenditure of so
large a sum for mere conductors that
it was not deemed practicable to
locate a number of lamps or other
devices for the translation of electricity
into a visible effect at a distance from

the source of supply of the current, 11193
that is this consideration negatived the
idea of a general system of generation
distribution and translation.

With such carbons an absolutely
perfect contact between carbon and
clamps was necessary in order that
there should be less resistance at the
clamps than in the body of the carbon
a large heating effect would be devel-
oped there, destroying the clamps. 11194

In addition the low resistance carbons
hitherto used have been unyielding and
inflexible, with a considerable degree of
expansion under the influence of heat
its degree of co efficient or expansion
being different from that of its holders.

This unequal expansion of the
carbons and its holders has resulted in
fractures of the former destroying the
lamps, or in its working loose from 11195
ts holders so that perfect contact
ceased, whereupon an arc was developed
thereat instantaneously destroying the
lamp. To obviate these dangers much
ingenuity has been expended upon the
carbon holders or clamps, so that they
would maintain good contact and at
the same time allow for the expansion
of the inflexible carbon. For such pur-
pose spring contacts, roller contacts, etc. 11196
have been devised, but such expedients
were either complicated or costly or
unreliable. Take in margin.*

The unyielding and inflexible nature of the low resistance carbons heretofore used also rendered them liable to fracture from jars received in transportation, and when attached to structures subjected to undue vibration from any cause.

---

* At this point in the original exhibit, appear in pencil the words "Take in margin," and the matter here appearing in the margin *in print* is written in *pencil* in the original.

In the original there also appear in the left-hand margin, written in pencil, the words, "Insert amdt 10," with marks of erasure drawn over them.

11197 Moreover when it has been attempted
to use such carbons in an artificial
atmosphere, that is in a n non-azotic*
gas, it was found that there was
a lower degree of economy, that is
that fewer candle-power per horse
power could be obtained, than when
a vacuum was used. Convective currents
were set up in the gas by the heat
11198 of the incandescent conductor heating
the glass to a dangerous degree by
carrying and to a greater extent
than when a vacuum was used. In
addition in such and in any atmospheres
there is by the action of the current
an absolute carrying of the carbon from
one pole to the other gradually destroying
the carbon. The amount of this
action is directly dependent upon the
11199 amount of any atmosphere present, being practically‡
nil in a perfect vacum.
These faults, as before stated, have
caused the failure of the attempts hitherto
made to practically use the principle
of incandescence in electric lamps.
The object of this invention is to pro-
-duce a lamp which shall obviate all
these objections and faults, rendering
11200 practicable a system of incandescent
electric lighting, [and to that end it
consists primarily in a relatively high
resistance flexible carbon, say of from
10 ohms to as high a degree of resis-
tance as can be made, which is only
limited by the action of electrical carry-

*In original changed in pencil to "an azotic."
‡In original the word "practically" is in pencil.

ing, for the incandescing portion, and 11201
secondly in matters attendant thereon,
all as more fully hereinafter set forth
and claimed.]*
In carrying my invention into prac-
-tice it is necessary to manufacture car-
-bon specially therefor, for in order to
obtain the necessary resistance in a
length permissible for use in a lamp
designed for ordinary purposes, the
carbon must be exceedingly small in 11202
cross section, so small that its di-
mensions are best expressed by apply-
-ing to it the term filament, it being
thread-like in size. Such a carbon
cannot be made by reducing or
cutting or forming bulk carbon.
Moreover such carbon is inflexible and
unyielding. To obtain the necessary
carbon, a carbonizable material must
be cut or formed into the shape de- 11203
sired and then carbonized. For this
purpose paper is a very desirable
material, the variety known as
"bristol board" being especially so.
The paper should be of the desired
thickness and as free as possible from
foreign substances and adulterations.
With suitable instruments, such as
a punch and die, I cut out a narrow 11204
strip of this paper, preferably in the
form of an elliptical bow or an arc
of a circle, the ends of the strip
being by preference wider than the other
portions.‡

* In the original exhibit all of this paragraph which is within the brackets is erased *by pencil*, and in the margin opposite the lines thus erased appear in pencil the words "Omit, Erase and insert Amdt. 10," with pencil marks of erasure drawn over the words "Erase and insert Amdt. 10."

‡ In the original exhibit there appear, *in pencil*, in the margin opposite this paragraph, the words "Insert Am'd't 11. See Am'd't 5, long insertion, about enlarged ends"—with pencil erasure drawn over such entry.

11205 A number of these pieces of paper
are laid flatwise in the bottom of a
mold, preferably of wrought iron, and
there is laid on them a light weight
in the form of a flat piece of gas
retort carbon or other device that will
not be distorted by the heat. If
several of these are laid one on the
other in the mold, a piece of tissue
paper is interposed between each one
11206 and the next.

A cover is used to cover the mold
and the mold is raised very gradually
to a temperature of about six hundred
degrees Fahr. This allows the volatile
portions of the paper to pass away and
at the same time the mold retains
the paper in its proper shape and
the paper is prevented from curling
up or becoming distorted as it would
11207 be likely to do if the heat was ap-
plied suddenly, or the light weight
dispensed with.

The mold is then raised almost
to a white heat and then removed and
allowed to cool gradually.

The carbon filaments thus pre-
pared will be found to have a very
high resistance in small bulk and
to be very uniform in their resistance
11208 and to be sufficiently strong for the
handling attendant upon their embodi-
ment in lamps and their use therein.

They will also be found to be very
flexible, so that expansion and contraction
resultant upon their heating and cooling
when in use, may proceed without
danger of fracture.

Take in A press copy.
Take in B yellow sheet. }*

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* In original exhibit these words are in pencil, and in the opposite margin there are written in pencil the words "Insert Amdt. 10," with erasure marks drawn over them.

Desirable means for embodying the 11209
invention for practical use are shown
in the drawings in which

Figure 1, is a vertical section of the
lamp complete.

Figure 2, is a side view in larger
size of the clamping device.

Figure 3, is a section at the line
x—x in still larger size.

Figure 4, is the wire forming one of
the clamps before it is bent 11210
up to shape.

Figure 5, is the paper blank before
it is carbonized.

The blank a is cut out of paper
material such as "bristol-board" in
loop or horse-shoe ‡
the proper shape, and then carbonized
as hereinbefore explained.

flexible†
So treated it becomes the carbon ∧ fil- 11211
ament i which forms the light-giving
portion of the lamp when rendered
incandescent by an electric current.

It will be noted that these carbons
are made with enlarged ends a' a'
which are homogenous with the body
of the carbon, the blank being proper-
ly fashioned therefor. These enlarged
ends give an increased surface for
the clamps which are to receive and 11212
support the filament, thereby ensuring
a better electrical contact between them.*

The lamp is made as follows—
An enclosing globe m is made of
glass with a neck g sufficiently large
filament†
to permit the ∧ i to pass there through,

---

‡ These words interlined in pencil, and the word "proper" erased by pencil.

*In the margin of the original, opposite this paragraph there appear, *in pencil*, the words "The ends being gradually enlarged, preferably in one plane as shown and"—with pencil marks of erasure over them.

† In the original exhibit the interlined words "flexible" and "filament" are written in pencil

11213 opposite thereto a tube *k*, indicated
in dotted lines being formed. A
supporting neck *n* is made with an
enlargement *n'* equal in size to *g*
the top being finished as shown at
n''. Through *n''* pass the wires which
lead to the clamps supporting the carbons.
The portion passing through should be of
platinum. These wires are sealed into
the neck at *n''* by a melting of the
11214 glass around them, and they may be
further sealed in and protected if
necessary by tubes A secured with *n*
and sealed around the wires, upon
the upper end of the conductors to
the carbons are secured in proper
clamps, which may be made of wire
h at the ends of which are tips or
small rivets *r* of platina or similar
material. The wire is bent up and
11215 crossed as shown so as to act as a
spring in clamping the end of the
carbon filament that is placed within
such clamp. The wire *h* passes
through small stock *o* into which
the conducting wire *l* passes and is clamped.

The carbon being secured in the clamps
and the clamp stocks and conductors in
proper position on *n* the latter is
11216 introduced within the neck of the bulb
m and the glass melted at *r*, the air
is exhausted from the globe by the tube
k, which originally is as shown by
dotted lines but which is melted
together while the vacuum is main-
tained when a proper vacuum has
secured as before set forth.
been attained. explained.

The lamp is now ready for placing in circuit when the carbon is rendred incandescent by the current that passes through the same. It is durable as there is nothing to combine with the carbon and it is substainally indestructible.* 11217

The result is the lamp shown in figure 1. A lamp in which the
flexible
incandescing portion *i* is a ▾ filament 11218
and in which all incandescing portions of the filament radiate available light.
of high resistance flexible carbon ▴

The high resistance permits of the use of conductors *t* so small that they may be safely sealed in the glass itself, avoiding the use of seals made of foreign substances, the lamp although made of several pieces of glass being now substantially of one piece 11219
of glass, so that the vacuum may be effectually preserved.

In addition it permits of the use of conductors from the source of energy to the lamp proportionately smaller, so that economy therein is subserved which in practice means that a system is possible without that outlay in conductors which rendered hitherto the idea of such a system impracticable.‡ 11220

Further, the clamps that connect the conductors to the ends do not require to be pressed with much force on the

---

*In the original this sentence has pencil marks drawn over it, and in the margin are written in pencil the words "Take in."

‡ In the original there appear in pencil, in the margin, opposite this point, the words: "It also allows of an even distribution of light among the lamps of a large system."

Edison's Application of Dec. 15, 1880

The lamp is now ready for placing in circuit when the carbon is rendred incandescent by the current that passes through the same. It is durable as there is nothing to combine with the carbon and it is substainally indestructible.*

The result is the lamp shown in figure 1. A lamp in which the flexible incandescing portion i is a v filament and in which all incandescing portions of the filament available light. of high resistance flexible carbon

The high resistance permits of the use of conductors t so small that they may be safely sealed in the glass itself, avoiding the use of seals made of foreign substances, the lamp although made of several pieces of glass being now substantially of one piece of glass, so that the vacuum may be effectually preserved.

In addition it permits of the use of conductors from the source of energy to the lamp proportionately smaller, so that economy therein is subserved which in practice means that a system is possible without that outlay in conductors which rendered hitherto the idea of such a system impracticable.‡

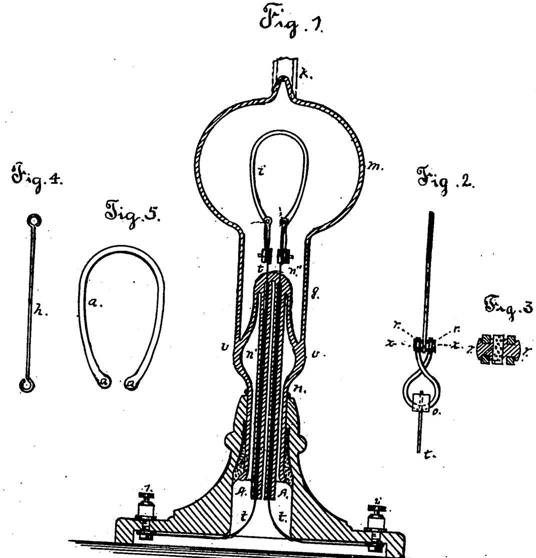
Further, the clamps that connect the conductors to the ends do not require to be pressed with much force on the

* In the original this sentence has pencil marks drawn o… and in the margin are written in pencil the words "Take h…

‡ In the original there appear in pencil, in the margin, op… this point, the words: "It also allows of an even distrib… light among the lamps of a large system."

Defendants Exhibit
"Edisons Divisional Application No. 1½"
S.M.H. Jr.

Case 264



Attest
D. D. Mott.
G. W. Howard

Inventor
Thos A. Edison
per Dyer and Wilber
Atty.

11221 carbon, because the resistance to the
passage of the current between the
clamps and the carbon will be less
than the resistance of the carbon fila-
ment, hence but little heat will be
developed at the clamps.

The flexibility secures it against
fracture and against disruption from
its clamps, also permitting the lamp
to be used in situations where there
11222 is jar or shaking which would forbid
the use of ordinary carbons.

If the requisite high degree of
vacum be produced, the carbon is
durable as there is nothing in the
lamp to combine with the carbon or
to aid in the carrying of carbon be-
fore noted, and as the lamp is
homogeneous and of one piece, the
vacuum is preserved, and the lamp
11223 under normal usage, is practically
indestructible. at a medium incandescence

A carbon made of paper is not
claimed herein, as such is the subject-
matter of an application for a patent
made by me on the 11th day of Dec.
of which this application is a division
1879, but—

What I do claim is—

First. An incandescing conductor for
11224 an electric lamp consisting of
a filament of carbon of relatively
high resistance, substantially
as hereinbefore set forth.

Second. An incandescing conductor for
an electric lamp consisting of a
filament of flexible *carbon, sub-
stantially as hereinbefore set forth. ‡

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* In original there are pencil marks indicating that the word "flexible" is to be transposed to stand before the word "filament."

‡ The inter-lined words on this page are written *in pencil* in the original.

Third. An incandescing conductor for 11225
an electric lamp consisting of
a filament of relatively high
resistance and flexible carbon, sub-
stantially as hereinbefore set forth.

Fourth. An electric lamp for giving light
by incandescence consisting of a
filament of high resistance and
flexible carbon hermetically sealed
within an enclosing globe made
entirely of glass substantially as
hereinbefore set forth.* 11226

Fifth. The combination of flexible carbon
filaments of high resistance, an ex-
hausted enclosing globe made en-
tirely of glass and conductors
passing through and sealed into the
glass substantially as hereinbefore set
forth.*

Sixth. A carbon for electric light made
as a filament with broadened or
enlarged clamping ends, substan- 11227
tially as hereinbefore set forth.*

Seventh. The clamp composed of a
bow or elliptical spring with
the ends crossing each other
and adapted to receive between
them the carbon, substantially
as herein before set forth.

Eighth. The method herein specified
of manufacturing carbons for electric
lights consisting in exposing the 11228
filament of paper to the action
of heat in a mold to drive

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*In the original exhibit the word "erased" is written in pencil in the margin, opposite each of claims 4 and 5; and the word "Sub." opposite claim 6.

Also pencil marks of erasure are drawn across claim 6.

11229 off the volatile portions, and then raising to a higher heat to fully carbonize the paper, substantially as set forth.*

6th. A blank of carbonizable material for forming ‡

* In the original exhibit there are pencil marks of erasure drawn over claim 8, and the word "out" appears in the margin in pencil opposite said claim.

11230 ‡ This claim in the original is *in pencil*, the other claims and the specification being written in ink.

Defendant's Exhibit, "Edison's Divisional Application, No. 2."

S. M. H., Ex.

[Letter of transmittal, Dec. 15, 1880.]

In Re Edison. Application No. 264.

11231 To the

Hon. Commissioner of Patents.

Sir:—

Attention is called to the paper of amendment filed in case 187, upon the date of the filing of this application.

This is the application referred to in remarks accompanying the amendments in such paper, and is

11232 filed under the provisions of Rule 125, as embracing non interfering subject matter eliminated from that application.

Very respectfully,

Attys. for Edison. *

* The original exhibit has at the bottom of this page, in pencil, "Please correct on pages 3 & 15."

Also, it has an endorsement in pencil, "Appl'n."

Complainant's Exhibit, "Edison's Divisional Application, No. 3." 11233

S. M. H., Ex.

[*Rejection: Feb.* 10, 1881.]

Room No. 91. (2—071.)
All communications should be addressed to
"The Commissioner of Patents,
Washington, D. C."

DEPARTMENT OF THE INTERIOR, 11234

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., February 10th, 1881.

THOS. A. EDISON,

Care DYER and WILBER *

Present.

Please find below a communication from the examiner in charge of your application No. 22,301 for a patent for improvement in Incandescent Electric Lamp, filed Dec. 15th, 1880, 11235

Very respectfully,

E. M. MARBLE,

Commissioner of Patents.

Electro's (7716-50M.)

The above named application has been examined.

The term "non azotic gas" is employed in the specification in respect to the medium in which the lamp or 11236
the incandescent portion thereof is to be placed.

The first 6 claims are not found to present anything patentable in view of the patent to applicant 223,898 of

(over)

11237 January 27th, 1880. The applicant in such patent states that he may carbonize paper for his incandescing conductor which would possess all the qualities claimed. In connection with the 6th claim see also English patent No. 12,212 O. L.

In the 7th claim the word receiving—should be changed to "adapted to receive" It is thought
11238 that this would improve the form of the claim.

The 8th claim is thought to cover a separate invention and one which could be properly examined only in a different division of the office, and should therefore be eliminated from the present application.*

11239 * Endorsed in pencil "(1) Feb. 10, '81."

11240

Defendant's Exhibit, "Edison's Divisional Application, No. 4." 11241

. S. M. H., Ex.

[*Argument and Amendment: April 3, 1882.*]

"Incandescent Electric Lamp." 22,301.

Dec. 15, 1880.

February 10, 1881.

In 7th claim substitute for "receiving", "adapted to receive." 11242

Erase from this case the 8th claim, which at the proper time by proper amendment will be restored to Mr. Edison's prior application No. 187, filed December 11th, 1879, from which it was taken for embodiment in this case.

The claims presented in this case cover matters of substance, the vital improvements and advances in the art 11243
which have made, or have at least been prominent factors in making Mr. Edison's system the success it is. His inventorship in the premises has not been disputed, and he is entitled to protection therefor.

Under the late rulings of the Supreme Court, Mr. Edison cannot obtain valid protection therefor by re-issue of his patent 223,898. 11244

The invention covered by that patent, viz. a certain incandescent electric lamp does not "form the essential features of the invention, such "as is now specifically claimed."

(See Commissioner's decision, ex parte Maxim, December 14th, 1881.)

11245 Under the practice of the Office, following the decisions of the Courts, we are entitled to a separate patent for the matters of invention not claimed in a prior patent, even though such matters might be suggested by or inferred from the prior patent.

As to the reference given for 6th claim, Staite English 12,212. O.
11246 L. we fail to see that it hits the claim. In one case in using iridium Staite's drawing shows the— which passed out of the chamber somewhat enlarged, but it was not a filament, it was not carbon, it has not broadened or enlarged clamping ends. His iridium was in a round bar, a simple staple with ends enlarged in the drawing
11247 in every direction but still giving no better clamping service than the smaller portion.

If the reference is good for our claim it should have been good for the patent lately granted Maxim.

In view of all the circumstances it is hardly conceivable that
11248 the office will insist on the reference.

In view also of these things a favorable re-consideration is confidently requested.

Z. F. Wilber,
Attorney for Edison.*

April 3rd, 1882.

* Endorsed: "(2) Erase 8th. Apr. 3, 1882."

Complainant's Exhibit "Edison's Divisional Application, No. 5." 11249

S. M. H., Ex.

[*Rejection; April* 10, 1882.]

Room No. 91. (2-071.)
All communications should be addressed to
"THE COMMISSIONER OF PATENTS,
Washington, D. C."

DEPARTMENT OF THE INTERIOR, 11250

UNITED STATES PATENT OFFICE.

Washington, D. C., April 10, 1882.

T. A. Edison,
Cr. Z. F. Wilber,
Box 252. Present:

Please find below a communication from the EXAMINER in charge of your application No. 22,301
for a Patent for Improvement in Electric Lamps, 11251
filed Dec. 15, 1880.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Electro's (8764–50,000.)

Applicant states that the invention covered by his patent 223,898 does not form the essential feature of the present case, and yet the first claim 11252
in both the patent and the application is for substantially the same invention namely a high resistance carbon. It is thought not that the Maxim decision applies in any respect to this case.

11253 The subject matter of the first six
claims in the present case cor-
responds with the statement of in-
vention and advantages of the various
features as set forth in the original
patent, and the gist of the claims leav-
ing functions aside is the same in
both cases.

Where an inventor in attempting
to illustrate an invention incidentally
11254 shows another distinct invention which
he neither describes, nor in the re-
motest degree claims, and the ad-
vantages of which he does not set
forth; then it would appear that he
could by the exercise of due diligence
make a separate application for
such distinct invention, which
could not of course be protected
by reissue in any case. But this
11255 would certainly not justify grant-
ing new claims for an invention
which has already been attempted
to be protected in another prior case,
much less when the claims are substan-
tially the same as the old ones, or at the
most only varied by reference to other
functions of the devices. English patent
No. 3809 of 1872 is cited as an addition-
al reference against the 6th claim.

11256 All the claims except the 7th are again
rejected for the above reasons and
those formerly given.*

* Endorsed in pencil "(3.) 264.
Apr. 10, '82."

Defendant's Exhibit, "Edison's Divisional Application, No. 6." 11257

S. M. H., Ex.

[*Amendment and Argument; May* 16, 1882.]

Incandt. Electric Lamps. 22,301.
Dec. 15th, 1880.

April 10th, 1882.

First as to the additional reference given 11358
for 6th claim, Konn's English Patent, No. 3809 of
1872. Konn took a piece of graphite carbon
(presumably gas retort carbon) and reduced
it in size in the center. This was entirely
different from a filament of carbon.
The construction there, with what was in
comparison to a filament, a large mass of
carbon, would not suggest the construction
claimed in a filament. Even though a 11259
large hard piece of carbon had had its
center turned or sawed down, the feasibility
of the construction claimed of a filament
had to be demonstrated and a method
devised for accomplishing it.

In Konn's day a filament of carbon was
unknown, the small delicate bits of carbon
now used as incandescents, were first brought
to public notice by Mr. Edison and their very
designation "filament" was first applied to 11260
them by him. So far as the records show he
invented the thing and christened it, and
Kohn's device can no more anticipate the
construction claimed in the 6th claim that it
can anticipate the thing "filament" or the use
of the term "filament" applied thereto.

11261 His patent is a good or a bad reference for all, it cannot be good for a part and bad for a part. As Konn never had "a carbon made as a filament" either with or without enlarged ends, I must insist upon the claim and in addition amend by inserting the following claim:

Seventh: "A filamentary carbon for incandescent electric lights having broadened
11262 or enlarged ends homogenous with its body or light giving portion, the whole formed by carbonization of a blank of carbonizable material having enlarged or broadened ends left upon it in the course of its preparation substantially as set forth."

Change designation of original 7th claim to 8th.

As to the general grounds of rejection, viz.
11263 Edison's prior patent No. 223,898, the Maxim decision does apply so far as there is any matter common to the patent in this case.

The ennunciation of doctrine in the office letter is very smoothly written and reads very well, but the letter has one grave fault, viz. an absolute misstatement of the facts in this case, and without the misstatement the doctrine don't apply.

The letter says "the 1st claim in both the patent and the application is for
11264 substantially the same thing." Is it so?

Now the 1st claim in this application is for a "filament of carbon of relatively high resistance, substantially as hereinbefore set forth," that of the patent is for a lamp "consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires as set forth." In penning

the sentence from the letter quoted above 11265
the Examiner must have lost sight of the words underscored in the extract from the claim of the patent. What does the specification say as to "made as described". The treatment and mixing of certain materials, rolling them into a wire, winding the wire into a spiral and then carbonizing the same. This is the "made as described" and this is the only carbon protected by the claim.

11266

Next the letter states that the first 6 claims of the application correspond with the statement of invention etc. in the patent, and the gist of the claims leaving functions aside is the same in both cases. Is this so?

The 2nd claim is for a flexible carbon (Mr. Edison so far as I can learn is the first to have ever made flexible carbon).

In the patent, either in specification or
claim, there is not one word as flexibility 11267
or a flexible carbon. The 3rd, 4th and 5th claims bring in high resistance and flexibility. The remarks supra as 1st and 2nd claims apply to this. It is easy to make the general statements contained in the letter but I challenge the Examiner to show a claim in the patent whose "gist" is the same as any claim in the application.

The subject matter of the 6th claim is shown
in the drawing of the patent as incidental to 11268
what is claimed in the 4th claim of the patent, but it is not described or claimed therein.

The invention herein claimed has not "already "been attempted to be protected in another prior case" and in the statement "at the most only varied by reference to other functions"

11269 there is an evident confusion of functions with characteristics or properties, for the claims do not stand on "functions" but characteristics that give them individuality and segregates them from what was before known in this art.

From this it appears that the only matter common to both cases is first the high resistance of the carbons, but this is immediately differentiated by the limitation in the patent to it "made as described" therein; the high
11270 resistance being only incidental to the invention there claimed, and second, the enlarged ends, which are shown there only as incidental to the method of uniting the carbon and the wire.

Now to just such cases the Maxim decision applies, for neither of the features incidentally shown or alluded to in the patent "form the essential features of the invention, such as is now specifically claimed."

11271 The claims recite matters of invention, original with Mr. Edison, they are useful and important, lying, as they do, at the very base of the past two years successful development of incandescent lighting.

Mr. Edison under the law, is somewhere entitled to the protection of the law therefor, he has not that protection in his patent referred to, it has not been attempted to get that protection in that case, he can
11272 not legally obtain it by reissue of that case.

This application is the way to obtain it under the decisions of the Courts and the Commissioner, and upon the allowance of this application I must insist.

Atty. for T. A. Edison.*

May 16th 1882.

*Exhibit endorsed in pencil "(4) May 16, '82, inserts 7th claim.'

Defendant's Exhibit, "Edison's Divisional Application, No. 7." 11273

S. M. H., Ex.

[*Amendment; May* 23, 1882.]

T. A. Edison
Serial No. 22,301
Incandt Elec. Lamps
Filed Decr 15—1880.
Edison Case 264
Room 91.

Hon. Commr. Patents.

Sir: 11274

I hereby amend this case as follows, the numbers given to pages herein referring to mss pages in the original specification.

In line 3 page 1 for "incandescing" substitute "incandescent."

In lines 16 and 17 page 1 erase "a non azotic gas" and substitute "an azotic or non-combustion supporting gas" 11275

In line 4 page 8 erase "a non azotic gas" and substitute "an azotic gas"

In line 25 page 8 after "being insert "'practically"

Erase lines 22, 23 & 24 page 10 and substitute

"circle, forming the
"blanks for carbonization.

"The size of the body of 11276
"the perfected carbon is not
"sufficient to afford the surface of car-
"bon for clamping at the
"ends necessary to insure good elec-
"trical contact, and they should there-
"fore be provided with enlarged
"ends. In my application bearing
"serial number of the United Patent
"office 5864, is shown one method
"of furnishing these enlarged ends,

11277 "viz. by carbonizing upon the ends of
"the carbon a separate button or
"knob of wood forming contact
"with the ends of the incandescing
"conductor and the conducting wires
"and uniting them together, the end
"of the carbon being thereby practically
"enlarged in all directions or planes.
" I have found however that the
"same result may be attained
11278 "in a much simpler and more e-
"conomical way and which is
"therefore preferable, viz. by cutting
"or shaping the blank with its ends
"enlarged in one plane, preferably
"the plane of its greater dimensions
"or breadth."

After "Carbon", line 11, page 13
insert

11279 "the enlargements being
"entirely in one plane, and prefer-
"ably as here shown, in the plane
"of larger dimension or breadth."

Erase 6th and 7th claims and
substitute

"Sixth.—* A blank of carboni-
"zable material for forming a filamentary
"incandescent carbon cut or formed
"with ends enlarged in one plane
11280 "substantially as set forth.

"Seventh.—‡ A carbon for
"incandescent electric lights, made as a filament
"with its ends broadened or enlarged
"in one plane, substantially as set forth."

May 23d, 1882.

T. A. EDISON, per
Z. F. WILBER,
Atty. †

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* In the original, "Sixth" is erased and "4" substituted in pencil.

‡ In the original, "Seventh" is erased and "5" substituted in pencil.

† Original endorsed in pencil;
"(5) May 23-82, puts in new 6th and 7th."

Complainant's Exhibit "Edison Divisional Application, No. 8." 11281

S. M. H. Ex.

[*Rejection, June* 1, 1882.]

Room No. 91 (2-071) E 264.
All communications should be addressed to
"THE COMMISSIONER OF PATENTS
WASHINGTON, D. C."

DEPARTMENT OF THE INTERIOR, 11282

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., June 1, 1882.

T. A EDISON,
Care Z. F. Wilber,
Present.
Box 252.

Please find below a communication from the EXAMINER in charge of your application No. 22,- 11283
301 for a Patent for IMPROVEMENT IN INCANDESCENT ELECTRIC LAMPS, filed Dec. 15th 1880.

Very respectfully,

Electro's (8764-50,000) E. M. MARBLE,
Commissioner of Patents

The first claim of patent 223,898 does not broadly cover an incandescent filament of high resistance, it must be held to cover at least
a species of such a generic invention, and as
the inventor of a species is also the inventor 11284
of the genus, a generic claim cannot be allowed in an application subsequent to one in which the species is claimed. Admitting then with applicant that the first claim of this case is broader than the corresponding claim of

11285 the said patent it must still be rejected
for the reason that if applicant is entitled to
such claim at all it can be allowed only
in a reissue of the said patent.

The reason why the said patent is also
a reference [*to*] 2d claim—covering a flexible carbon—
is that the carbons in both the patent and
this application are made from the same
materials by the same method and consequently
11286 the product in both cases would have the
same characteristics. Applicant is not
however the first to have made flexible
carbon for electric lamp as such carbons
are described in Compes Rendus LXX p. 605
which description is cited as an additional
for the second claims.

The 3d 4" & 5" claims are also again rejected on
the references 223,898 for whether we call the
properties of a device "functions" or "characteris-
11287 tics",
it is evident that after an inventor has once
patented an invention he cannot come in
from time to time and obtain additional
patents for such characteristics. Such a
course would evidently be a fraud on the
public, as an inventor could thereby keep on
patenting the same device as long as he
could find characteristics.

Thus to take a special case the public
11288 at the expiration of patent 223,898
should be entitled to make and use the
invention described therein but it is
evident that such manufacture and use
would infringe the present case were
it granted and sustained.

The description in Comptes Rendus above
referred to is also cited as an additional

reference to the 3d 4" & 5" claims to show 11289
that flexible carbons are not original with
applicant. The 6th & 7th claims unless still more
limited are broad enough to cover the filament
described in applicants former patent 238,868
Mch 15" 81 (Incandescent) which was filed before
this application. These claims are also met by
Swan 233,445 Oct 19"/80 & Maxim 230,310 July 20/80
(Elec Lights—Incandescent)*

* Original endorsed in pencil "(6) June 1, '82." 11290

Complainant's Exhibit "Edison's Divisional Application, No. 10."

S. M. H., Ex. 11291

In Re Edison. Case 264.

IN THE UNITED STATES PATENT OFFICE.

Serial No. 22,301.
T. A. Edison
Incan't Elec. Lamps
Filed Dec'r 15th, 1880.

STATE OF NEW JERSEY, } ss.
County of Middlesex. } 11292

Thomas A. Edison being
duly sworn deposes and says that he
had made the invention set forth
and claimed in the above named application
and had reduced the same to
practice long before the 1st day of January
1880.

Sworn to and subscribed before me this
day of June 1882.

11293 **Complainant's Exhibit "Edison's Divisional Application, No. 9."**

S. M. H. Ex.

[*Letter of Wilber, June* 11.]

June 11th 2

R. N. Dyer, Esq.,
Menlo Park N. J.

Dear Sir—

11294 I was much disappointed not to have received ere this those Rail Road cases. Please send them to me at New York now.—

I enclose an affidavit which it is *very important* I should have on Tuesday, in N. Y.—It relates to flexible & high resis. carbons, and of course Edison made it prior to Novr. 79, but Jany. 1st 80 will answer the purpose in this case.—

Please send it in properly
11295 executed without delay

Very truly &c.
Z. F. Wilber.

Defendant's Exhibit "Edison's Divisional Application, No. 11."

S. M. H. Ex.

[*Argument of Applicant, July* 12, 1882.]

11296 Edison Case 264.

T. A. Edison,
Serial No. 22,301
Incand't Elec. Lamps
Filed Decr. 15, 1880.
} Room 91.

Hon. Commissioner of Patents.

Sir:

I hereby amend this case by erasing the 4th and 5th claims and adjusting numerals of remainder.

Erase 8th claim.

For the matter of the 4th, 5th & 8th claims thus erased separate application will be made at the proper time, it not being the intention to abandon the same or to waive any right thereto by this procedure. 11297

In the 2nd claim for "filament of flexible carbon" substitute "flexible filament of carbon".

Referring now specially to the grounds of rejection given in office letter of June 1st, we find that the gist of the objection to the 1st claim is that a generic claim cannot be allowed subsequent to a specific claim and that applicants remedy is by reissue. 11298

1st. There is no authority anywhere for the assertion "a generic claim cannot be allowed in an application subsequent to one in which the species is claimed," nor has any such doctrine been practiced. 11299

The simple question is, "is the later application patentable?" or "is each application patentable?"

"Thus to take a special case." A invents a new and useful shoe peg, say a twisted wire peg, and he also invents a shoe having several well and specifically defined characteristics, among which however is this particular peg. If by chance the shoe is applied for or patented a day or a year prior to the peg, is the peg therefore divested of patentability as a peg? In other words if a man is so skilled as to make two inventions, an article and an organization embodying the article is he to be prejudiced thereby? These queries carry their own answer. At the same time they are this case. 11300

11301 Mr. Edison was fortunate enough, through the exercise of his abilities, to find out what was the best carbon, in fact the only carbon fitted for economic incandescent electric lighting. He was also fortunate enough to invent a lamp eminently suitable for such lighting, utilizing to be sure that carbon, *when made in one particular way*, Because he has invented a *lamp*, is he to be
11302 deprived of protection for the carbon? Must he lose his peg because he invented a shoe? Is the office going to persevere in the assertion (practically) that it is a misfortune to have made the 2nd invention and to have received a patent therefor?

2nd. " It can be allowed only in a reissue of the said patent." If
11303 the Supreme Court be right in their late holdings on the subject of reissue, this patent 223,898 cannot legally be reissued.— It is not invalid or inoperative; invention is clearly set forth therein and succinctly claimed. It is operative and valid to cover that invention, and being so operative and valid, a reissue thereof would be invalid if the Supreme Court is right, and right or
11304 wrong, we, unfortunately perhaps in this case, have to submit to its ruling.

These remarks also to the 2nd claim and to the 3rd. The subject of that patent is not a carbon but a lamp, of which the carbon is *only one element*. To be sure the claims in this case might have been made in that (and if they have been, half the examiners would have required a division) but they *were not made therein*.

As they were not made therein, as they are for legitimately patentable subject matters, the fact that they are used in the lamp covered by that patent is not a valid objection, even were it an absolute fact. 11305

The carbon described in Comptes Rendus is not a reference.

The experiments detailed therein were primarily to demostrate the deposition of carbon from a hydrocarbon, the material, lint, thread, &c. 11306 being simply a base. There is nothing whatever to show that the resultant was a flexible carbon, from the treatment, subjected to heat in presence of a hydro carbon, we know as a matter of fact that a low resistence carbon would be the result, the reference is undoubtedly good for the matter formerly in interference 11307 between Sawyer & Man and Maxim but does not touch this case. Moreover there is nothing therein to indicate that there had ever been made or known for incandescent lighting "a flexible filament of carbon".

For these reasons we maintain that the 1st, 2nd and 3rd claims should be allowed.

As to the now 4th and 5th (late 6th & 7th) 11308 even if described in applts prior patent 238,868, they come clearly within the doctrine in the Commr's decision, ex parte Maxim. As to the other references the proper affidavits will be immediately filed,

June 12, 1882.

T. A. Edison
per Z. F. Wilber his atty.*

* Original endorsed in pencil "Erases 4th, 5th and 8th claims, June 12th, '82."

11309 **Complainant's Exhibit "Edison's Divisional Application, No. 12."**

S. M. H., Exr.

[*Rejection, July* 3, 1882.]

Room No. 91.

(2—071.)

All communications should be addressed to
"The Commissioner of Patents,
Washington, D. C.

DEPARTMENT OF THE INTERIOR,

11310 UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., July 3d, 1882.

THOS. A. EDISON,
Care Z. F. Wilber,
Present.

Please find below a communication from the EXAMINER in charge of your application No. 22,301 for a patent for Improvement in Incandescent Electric Lamps, filed Dec. 15, 1880.

Very respectfully,

11311 Electro's (8764-50,000.) E. M. MARBLE,
Commissioner of Patents.

It has been repeatedly held by the courts that when an inventor obtains a patent for his device he is entitled to all the uses advantages and characteristics which are inseparably connected with his invention or which flows therefrom.

11312 A patent for a certain device is therefore a reference for all claims covering characteristics of the device, and it is immaterial whether the subsequent claimant(to)be the patentee or not. Otherwise a certain device might be patented over and over again so long as different characteristics are pointed out which although well enough known were not previously claimed.

The Supreme Court has of late condemned the reissuing of patents with broadened claims after the patent has been (*in*) existence for some years; holding that such practice worked injustice to the public. The Court did not say that such broad claims, if subsequently though [*thought*] of should be protected by a separate patent, for it is evident that such a practice would work a still greater injustice as the monopoly would be just so much extended and a premium would be placed upon laches. In James vs. Cambell, O. G., Vol. 21 page 344, the Supreme Court said :— 11313 11314

"It is hardly necessary to remark that the
"patentee could not include in a subsequent
"patent any invention embraced or described
"in a prior one granted to himself any more
"than he could an invention embraced and de-
"scribed
"in a prior patent granted to a third person." 11315

Moreover rule 91 of the Rules of Practice which is binding on the examiner so long as it remains in force says:—

"Matter which is shown and described, and
"might have been lawfully claimed in an
"unexpired patent etc —cannot be sub-
"sequently claimed by the patentee in a
"separate patent but only in a reissue
"of the original patent." 11316

The question as to whether applicant can make the claims under consideration in a reissue cannot be entertained, but if applicant is entitled to make them in a reissue according to the above quotations he certainly is not entitled to claim them in a subsequent application. If however

11317 he is not entitled to claim them in a reissue because it would defraud the public of some of their rights, then he is certainly not entitled to claim them in a patent which will cover the same ground as a reissue and last two or three years after the original had expired.

In view of the above and reasons set forth in the former official letters, the
11318 first, second and third claims are a second time and finally rejected.

In support of this decision the examiner would cite the decision of the Circuit Court in Mackay *et al. v.* Jackman etc. O. G. Vol. 22 p. 3.*

*Original endorsed in pencil, "8 July 3, '82."

11319

11320

Defendant's Exhibit "Edison's Divisional Application, No. 13." 11321

S. M. H., Ex.

[*Applicant's Letter ; July* 28, 1882.]

22,301

INCANDESCENT ELECTRIC LAMPS.

Dec. 15th, 1880.

July 3d. 1882.

The office letter noted states that "in view of the above and *reasons set forth in the former official letters*, the 1st, 2d and 3d claims are a second time and finally rejected." 11322

As to what is included under the phrase "reasons set forth" are somewhat in doubt, a doubt we should like resolved before proceeding further.

Our impression is that the summation of the letter of July 3d and of the "reasons set forth in previous letters" is that Edison is not legally entitled
to the 1st, 2d and 3d claims in view of his even prior patent No. 223,898, the letter of the 3d and the "reasons" referred to giving fully the grounds upon which the Examiner proceeded to such decision. 11323

Are we right in this impression, or is it intended to include other references than the prior Edison patent in this final rejection?

A fair, square understanding on this point tends to simplify matters and render future proceedings
easier for both Examiner and applicant. 11324

An answer to the question is therefore requested.

T. A. EDISON,
Per Z. F. WILBUR,*
His Attorney.

July 28th, 1882.

* Original endorsed in pencil "(9) July 28 | 82."

11325 **Defendant's Exhibit "Edison's Divisional Application, No. 14."**

S. M. H., Ex.

[*Amend t of Specification and Claims, Aug.* 18, 1882.]

Thos. A. Edison,
Incandescent Electric Lamps,
Filed Dec. 15, '80.
Serial No. 22,301 (Edison's No. 264).

To THE HON. COM. OF PATENTS:

11326 I respectfully submit the following amendment:

After 7th page of specification, insert—

The unyielding and inflexible nature of the low resistance carbons heretofore used, also rendered them liable to fracture from jars received in transportation, and when attached to structures subject to undue vibration from any cause.

On 3d page erase commencing with 8th line through 17th line and insert—

11327 incandescing electric lamps embodying the following elements, viz.: an exhausted and hermetically sealed glass chamber, and in [an] incandescing conductor contained thereby, composed of a flexible carbon filament of relatively high resistance—say of from 10 ohms to high a degree of resistance as can made, which is only limited by the action of electrical carrying—

11328 On 12th page of specification after 11th line insert—

This flexibility also prevents fracture from jars to which the lamps are subjected, in handling and when attached to structures subject to undue vibration.

The flexible carbon filament of high resistance obtained as described is then placed in an inclosing chamber of glass. This is done by sealing the leading-in wires of the lamp into the end of a glass tube by fusing the glass around the wires, the wires where they pass through the glass being of platinum. These leading-in wires are provided with suitable clamps in which are placed the enlarged ends of the flexible carbon filament. The filament is

then passed into the open end of a glass bulk [bulb] which is fused to the side of the glass tube carrying the filament. 11329

The glass bulk [bulb] is then connected with suitable vacuum apparatus by vacuous [means] of a small glass tube prejecting therefrom. A Sprengel drop-pump is employed for the purpose. After a high degree of vacuum has been obtained, the flexible carbon filament is raised to incandescence by passing an electric circuit therethrough, and by cutting resistance 11330 out of the lamp circuit, the degree of incandescence is gradually raised until considerably beyond the degree of incandescence at which the lamp will be raised in use. This raising of the carbon filament to high incandescence during the exhaustion of the lamp drives the secluded gases out of the filament and clamps, increases largely the flexibility of the filament and fixes its shape.

This process is not herein claimed, but is covered by my application No 22,308 of even date with the 11331 [*this*] application.*

After the process of exhausting the lamp has been completed, the glass bulk [bulb] is heremetically sealed by fusing the glass tube leading to the air pump, and drawing the lamp away from the same, when the lamp is ready to be fitted up for use.

On 15th page, 11th line, insert after word "attained" the words—as before explained.

On 15th page erase words, "and while the carbon 11332 filament is incandescent" written in pencil in 12th line.

These words are in Mr. Edison's handwriting and were evidently added by him before signing the specification.

* Pencil marks are drawn over these words in the Exhibit.

11333 Same page, insert in ink the words written in pencil by Mr. Edison after "vacua" in 22d line, viz: "but is dependent upon the resistance of the lamp and the degree of incandescence."—

Same page erase 26th and 27th lines, and insert flexible filament of carbon of high resistance.

On 16th page insert after 18th line, the sentence, written in pencil by Mr. Edison, viz: "It also allows of an even distribution of light among the lamps of a large system."
11334

On 17th page after word "indestructible" in 18th line, insert words written in pencil by Mr. Edison, viz: "at a medium incandescence."

Erase 1st, 2d and 3d claims and insert—

First.—An incandescing electric lamp having in combination the following elements, viz:

11335 An exhausted and hermetically sealed glass enclosing chamber and an incandescing conductor, composed of a flexible carbon filament of relatively high resistance, substantially as set forth.

Change the numerals of the 4th and 5th claims to 2d and 3d.

Respectfully,
RICHD. N. DYER,
Atty. for Edison.*

Aug. 19, '82.

11336 * Original endorsed in pencil.
"10 No. 264
Aug. 19-82."

Defendant's Exhibit, "Edison's Divisional Application, No. 15." 11337

S. M. H., Ex.

[*Amendment erasing Claims; Aug. 23, 1882.*]

Thos. A. Edison,
Incandescent Electric Lamps.
Filed Dec. 15, '80.
Ser. No. 22,301, Edison's 264.)
To the Hon. Comm. of Patents:

I respectfully submit the following amendment, 11338
viz.: Erase amendment "C" forming part of paper filed May 23rd, 1882 and insert circle, forming the blanks for carbonization. These blanks are provided with gradually-enlarged ends, the enlargements being preferable in one plane only. No claim however is made herein to the enlarged ends, since it is intended to embody that feature in a separate application for patent.

Substitute for amendment "D" the following: 11339
the ends being gradually enlarged preferably in one plane, as shown.

Erase 2nd and 3rd claims and the numeral of 1st claim.

These claims are erased, since it is intended to cover all features of novelty relating to the enlarged ends and the spring clamps in a division of this case, which is a division of case No. 187.

Respectfully,
RICH'D N. DYER, 11340
Att'y for Edison. *

Aug. 23rd, '82.

* Original endorsed in pencil;
"11 264
Aug. 23, '82 Amd't."

11341 **Defendant's Exhibit, "Edison's Divisional Application, No. 16."**

S. M. H, Ex.

[*Substitute Specification of Jan. 13, 1883.*]

Thomas A. Edison,
Incandescent Electric Lamps.
Filed December 15th, 1880.
Serial No. 22,301 (Edison's No. 264.)

To the Commissioner of Patents,

11342 Sir:

In the above application I submit the following amendment, viz.:

Erase the entire manuscript portion of the specification down to and including the claims, and insert instead thereof the following:

The object of this invention is to produce an in-
11343 candescing electric lamp, which shall render practicable a system of electric lighting, including one or more buildings, wherein a greater or less number of lamps may be used, connected with the same system of conductors.

Many attempts have been made to produce a practical electric lamp, by causing an electric current to heat to incandescence a suitable conductor in a vacuum, or in an atmosphere of an azotic or non-combustion supporting gas, but no practically ope-
11344 rative lamp has yet been devised therefor:

For such lamps it is now universally known that carbon is the preferable material for the incandescing conductor.

Such carbons, in the attempts hitherto made have been of comparatively low resistance, ordinarily from two to four ohms, but never exceeding five ohms, so far as can be ascertained from the records of the art, being quite thick and bulky relatively to their length; and being formed of hard carbon, which has great density and mass per unit of volume.

It has been customary to treat carbon for such 11345
use, in order to lessen its resistance, that is, to take a pencil of carbon and increase its density, and conductivity, by the filling up of its pores with other carbons, for instance by the deposition caused by electrical incandescence due to a current traversing such carbon while immersed in a hydro-carbon vapor or liquid, or by soaking the carbon in a syrup, or other liquid rich in carbon, and then recarbonizing.

In fact the universal practice has been to reduce 11346
the natural resistance of the carbon, bringing it to a relatively very low point, and giving the carbon great density and mass per unit of volume.

In order to prevent undue heating of the conductors, it has been necessary to use with such dense or low resistance carbons, conductors of very low resistance, having such bulk, that owing to the different co efficients of expansion of the conductor and glass under heat, it has been impracticable to 11347
seal the conductors in the glass itself, or to form an inclosing chamber entirely of glass.

In all attempts hitherto made, the glass globe was therefore sealed by a foreign substance, sometimes metal caps with composition thereover, sometimes combinations of cements, gums, paraffine, etc., were used.

Such seals were not hermetical, and by their use it was not possibe to maintain the conditions existing within the lamp globe when first sealed. 11348
With a vacuum, air inevitably penetrated such a seal, destroying the lamp: and when an artificial atmosphere composed of an inert gas has been used, it has been found practically impossible to maintain perfect joints under the varying degrees of heat and pressure, because the expansion of the artificial atmosphere, due to the heat of the luminous conductor, expels a portion of the same through any such sealing, which is replaced, upon contraction by cooling, by external air.

11349 The large mass of conductor essential to these
low resistance carbons, formed means of convey-
ing large amounts of heat, endangering the glass
case and the sealing thereof, so that it became
necessary to interpose non-conducting plates and
to so construct the conductors, making by twists
and convolutions a great length thereof in the
lamp, as to prevent the heat reaching the glass and
seal.

11350 Such experiments could not prevent, but only
defer the effect, and hence were unavailing.

The necessary difference in the resistance of the
incandescing conductor and the conductors supply-
ing the same, necessitated in any attempt at a sys-
tem, the use of conductors of exceedingly low re-
sistance which could only be obtained by the use
of a great mass of material.

This involved the expenditure of so large a sum
for mere conductors that it was not deemed practic-
11351 able to locate a number of lamps, or other devices
for the translation of electricity into a visible effect,
at a distance from the source of supply of the cur-
rent, that is, this consideration negatived the idea
of a general system of generation, distribution and
translation.

With such dense or low resistance carbons, an
absolutely perfect contact between carbon and
clamps was necessary, in order that there should be
less resistance at the clamp than in the body of the
11352 carbon: otherwise a large heating effect would be
developed there, destroying the clamps.

By reason of the bulk of the incandescing carbon
conductors hitherto used, which made them rigid
and brittle, and by reason of the brittle nature of
the carbon of which such conductors were composed,
they have been unyielding and inflexible.

This defect alone was sufficient to render imprac-
ticable for commercial purposes the incandescing
electric lamps heretofore made.

The unyielding and inflexible carbon was liable
to be fractured by the jars to which the lamp would
be subjected in transportation and use.

The expansion of such carbon when heated to in-

candescence and its contraction when the circuit 11353
was broken, resulted, on account of the want of
flexibility, in the fracture of the carbon, destroying
the lamp, or in its working loose from its holders,
so that perfect contact ceased, whereupon an arc
was developed at such holders, instantaneously de-
stroying the lamp.

To obviate these dangers from the expansion and
contraction of the carbon, much ingenuity has been
expended upon the carbon holders or clamps, so
that they would maintain good contact and at the 11354
same time allow for the expansion and contraction
of the inflexible carbon. For such purpose, spring
contacts, roller contacts etc. have been devised,
but such expedients were either complicated and
costly or unreliable and did not remedy the defects
inherent in the carbon itself.

These faults have caused the failure of the at-
tempts hitherto made to practically use the principle
of incandescence in electric lamps. 11355

The object of this invention then is to produce a
lamp which shall obviate all these objections and
faults, rendering practicable a system of incandes-
cent electric lighting.

In my patent No. 223,898 is described one method
of carrying out the principal parts of this invention,
which method is herein claimed: but the invention
herein is anterior to the specific means of said pat-
ent, and consists broadly in constructing an incan-
descing electric lamp with an hermetically sealed 11356
chamber entirely of glass, inclosing an incandescing
conductor of carbon, and maintaining the condi-
tions, whether of vacuum or of an inert gas, exist-
ing within the enclosing chamber at the time of
sealing: further, providing such a lamp with a flexi-
ble carbon filament as the incandescing conductor,
permitting the conductor to expand and contract,
without the dangers before set forth which arise
from the use of an unyielding or inflexible con-
ductor, and also enabling the conductor to with-
stand without fracture the jars to which the lamp is
subjected in use, and diminishing largely the loss

11357 by breakage of carbon during the manufacture of the lamps: further, in making the flexible carbon filament for such a lamp, of relatively great porosity and small mass compared with the carbons heretofore produced, such result being obtained by the carbonization of organic or inorganic material, or of any compound, organic or inorganic, decomposible by heat into carbon, mixed or not with carbon, the volatile portion of the compound passing off during carbonization and leaving a carbon resi-
11358 due of great porosity and small mass, and producing a flexible filament of carbon having a relatively high resistance, say of from 15 ohms to as high a resistance as can be made, such resistance varying with the length and cross section of the filament and also with the porosity of the carbon residue: further, in constructing and arranging the flexible filamentary carbon conductor of such a lamp, so that all incandescing portions will radiate available light, and will not be partially obscured, as in my
11539 patent No. 223,898, the result of the construction shown in said patent being to concentrate the heat upon a smaller surface and produce a dazzling incandescence unpleasant or injurious to the eye: and further, in securing the ends of the flexible filamentary carbon conductor in such a lamp in fixed positions to the ends of the leading-in wires of the lamp, the flexibility of the filament permitting it to change its shape in contracting and expanding without danger of fracture.

11360 In carrying my invention into practice, it is necessary to manufacture carbon especially therefor, for in order to obtain the necessary resistance in a length permissible for use in a lamp designed for ordinary purposes, the carbon must be exceedingly small in cross section, so small that its dimensions are best expressed by applying to it the term "filament."*

* At this point in the original the words "it being thread-like in size" appear to have been once added, but subsequently to have been erased.

In such a carbon filament it is also necessary, in 11361
order to obtain the high resistance per unit of radiating surface requisite to high economy, that the carbon should have great porosity and small mass per unit of length.

Such a carbon filamant cannot be made by reducing, or cutting or forming hard carbon in bulk.

Moreover such hard carbon is inflexible and unyielding.

To obtain the necessary filament, it must be pro-
duced by the carbonization of a material or com- 11362
pound, organic or inorganic, structural or non-structural, which is decomposible by heat into carbon, the volatile portions of the material or compound passing off during carbonization and leaving a carbon residue having a great porosity and small mass compared with hard carbon.

The material or compound may be mixed with carbon before carbonization, as described in my patent before referred to, or the material may be a
naturally formed compound decomposible by heat 11363
into carbon, such as are all organic substances.

I prefer to use an organic material and to first cut or form it into the shape of a filament and then carbonize the filament, although the filament may be formed after carbonization.

For this purpose, paper is a desirable material, the variety known as "bristol board" being especially so. The paper should be of the desired thickness
and as free as possible from foreign substances and 11364
adulterations.

By the preferred method of constructing my lamp having a flexible filamentary carbon conductor formed from paper, I proceed as follows:

With suitable instruments, such as a punch or die, I cut out a narrow strip of the paper, preferably in the form of an elliptical bow or an arc of a circle, forming the blank or filament for carbonization. This blank is provided with gradually enlarged ends, the enlargements being preferably in one plane only.

11365 No claim however is made herein to the blank or filament of carbonizable material, or to the enlarged ends, since it is intended to embody these features in a separate application for patent.

A number of these filaments of paper are laid flatwise in the bottom of a mould, and there is laid on them a light weight, in the form of a flat piece of gas-retort carbon, or other device that will not be disturbed by the heat.

If several of these paper filaments are laid one
11366 on the other in the mold, pieces of tissue paper are interposed between them. A cover is used to cover the mould, and the mould is raised very gradually to a temperature of about six hundred degrees Fahrenheit. This allows the volatile portions of the compound of which the paper is composed to pass away, and at the same time the mould retains the paper in its proper shape and the paper is prevented from curling up or becoming distorted as it would be likely to do if the heat was applied sud-
11367 denly, or the light weight dispensed with. The mould is then raised almost to a white heat, and then removed and allowed to cool gradually. This method of carbonizing is not herein specifically claimed, since it is intended to cover the same by a separate application for patent.

The carbon filaments thus prepared will be found to have a very high resistance due to the great porosity and small mass of the carbon, and to be very uniform in their resistance.

11368 They will also be found to be highly flexible, so that the expansion and contraction, resultant upon their heating and cooling when in use, may proceed without danger of fracture, and so that they will be sufficiently strong for the handling attendant upon their embodiment in lamps and to withstand the jars to which they will be subjected in the transportation and use of the lamps.

The flexible carbon filament having relatively great porosity and small mass, obtained as described, is then placed in an inclosing chamber of

glass. This is done by sealing the leading-in wires 11369
of the lamp into the end of a glass tube, by fusing the glass around the wires, the wires where they pass through the glass being of platinum. These leading-in wires are provided with suitable clamps, in which are placed the enlarged ends of the flexible carbon filament, such ends being held in fixed positions by the clamps. This holding of the ends of the flexible carbon filament in fixed positions, makes it necessary for the filament to change its
shape somewhat in expanding and contracting, 11370
which it is enabled to do without fracture by reason of its flexibility.

After the filament is secured to the leading-in wires, it is then passed into the open end of a glass bulb, which is fused to the sides of the glass tube carrying the filament.

When a vacuum is to be employed, which is preferred to the inert gas, although the latter may
be used, the glass bulb is then connected with a suit- 11371
able vacuum apparatus, by means of a small tube projecting therefrom. A Sprengel drop pump is employed for the purpose. After a high degree of vacuum has been obtained, the flexible carbon filament is raised to incandescence, by passing an electric current therethrough, and, by cutting resistance out of the lamp circuit, the degree of incandescence is gradually raised until considerably beyond the degree of incandescence to which the lamp will be
raised in use. This raising of the carbon filament to 11372
high incandescence during the exhaustion of the lamp, drives the occluded gases out of the filament and clamps, increases largely the flexibility of the filament and fixes its shape. Good results, however, can be obtained without raising the filament to incandescence during the exhaustion of the lamp. This process is not herein claimed, since it is covered by my application No. 22,308 of even date with this application.

After the process of exhausting the lamp has been completed, the glass bulb is hermetically sealed, by fusing the glass tube leading to the air pump, and drawing the lamp away from the same, when the lamp is ready to be fitted up for use.

11373 A lamp embodying the invention is shown in the
drawing, in which:

Figure 1 is a vertical section of the lamp complete.

Figure 2 is a side view in larger size of the clamping device.

Figure 3 is a section at the line x–x in still larger size.

Figure 4 is the wire forming one of the clamps
before it is bent up to shape.

11374 Figure 5 is the paper blank before it is carbonized.

The blank *a* is cut out of paper, material such
as "bristol board," in the proper shape, and then
carbonized as herein explained.

So treated it becomes the flexible carbon filment *i*
which forms the light giving portion of the lamp
when rendered incandescent by an electric current,
and has relatively great porosity and small mass
compared with hard carbon.

11375 It will be noted that these carbons are made with
enlarged ends *a' a'* which are homogenous with the
body of the carbon, the ends being gradually enlarged preferably in one plane as shown, and the
blank being preferably fashioned therefor. These
enlarged ends give an increased surface for the
clamps which are to receive and support the filament, thereby ensuring a better electrical contact
between them.

The lamp is made as follows:—

11376 An enclosing globe *m* is made of glass with a neck
g sufficiently large to permit the filament *i* to pass
therethrough, opposite thereto a tube *k* indicated in
dotted lines, being formed. A supporting neck *n* is
made with an enlargement *n'* equal in size to *g* the
top being finished as shown at *n''*. Through *n''*
pass the wires which lead to the clamps supporting
the carbon.

The portion passing through should be of platinum. These wires are sealed into the neck at *n''*
by a melting of the glass around them, and they may
be further sealed in and protected if necessary by

tubes A secured with *n* and sealed around the wires. 11377
Upon the upper end of the conductors, to the
carbon is secured in proper clamps, which
may be made of wire *h*, at the ends of which
are tips or small rivets *r* of platina or similar
material. The wire is bent up and crossed as shown
so as to act as a spring in clamping the end of the
carbon filament that is placed within such clamp.
The wire *h* passes through small stock *o* into which
the conducting wire *l* passes and is clamped.

The carbon being secured in the clamps and the 11378
clamps, stocks, and conductors in proper position
on *n*, the latter is introduced within the neck of the
bulb *m*, and the glass melted at V, the air is exhausted from the globe by the tube *k* which originally is as shown by dotted lines, but which is
melted together, while the vacuum is maintained,
when a proper vacuum has been secured as before
set forth.

The lamp is now ready for placing in circuit;
when the carbon is rendered incandescent by the 11379
current that passes through the same.

The result is the lamp shown in figure 1, a lamp
in which the incandescing portion *i* is a flexible
filament of carbon having relatively great porosity
and small mass and a high resistance resulting
therefrom.

The high resistance permits of the use of conduct-
ors *l* so small that they may be safely sealed in the
glass itself, avoiding the use of seals made of foreign 11380
substances, the lamp although made of several
pieces of glass, being now substantially of one piece
of glass, so that the vacuum or other conditions ex-
isting at the time of completing the lamp may be
effectually preserved.

In addition it permits of the use of conductors
from the source of energy to the lamp propor-
tionately smaller, so that economy therein is sub-
served, which in practice means that a system is
possible without that outlay in conductors which
rendered hitherto the idea of such a system imprac-
ticable.

11381 It also allows of an even distribution of light among the lamps of a large system.

Further, the clamps that connect the conductors to the ends do not require to be pressed with much force on the carbon, because the resistance to the passage of the current between the clamps and the carbon will be less than the resistance of the carbon filament: hence but little heat will be developed at the clamps.

The flexibility secures it against fracture and
11382 against disruption from its clamps, also permitting the lamp to be used in situation where there is jar or shaking which would forbid the use of ordinary carbons.

A carbon made of paper is not claimed herein as such is the subject matter of an application for a patent made by me on the 11th day of Dec., 1879, of which this application is a division, but—

What I do claim is—

11383 *First:* An electric lamp giving light by incandescence, consisting of a hermetically sealed chamber entirely of glass, and a carbon conductor inclosed by the same, substantially as set forth.

Second: An electric lamp giving light by incandescence, consisting of a hermetically sealed glass inclosing chamber, and an incandescing conductor inclosed by the same,
11384 composed of a flexible carbon filament, substantially as set forth.

Third: An electric lamp giving light by incandescence, consisting of a hermetically sealed glass inclosing chamber, and an incandescing conductor, inclosed by the same, composed of a flexible, carbon filament, of relatively great porosity and small mass, substantially as set forth.

Fourth: An incandescing electric lamp 11385
having in combination a hermetically sealed glass inclosing chamber, and a flexible filamentary carbon conductor constructed and arranged so that all incandescing portions will radiate available light, substantially as set forth.

Fifth: In an incandescing electric lamp, the combination with a hermetically sealed
glass inclosing chamber, of leading-in wires 11386
passing through and sealed into the glass, and a flexible carbon filament, secured at its ends to such leading-in wires in fixed positions, the flexibility of the carbon filament preventing fracture by expansion and contraction, substantially as set forth.

Respectfully

RICHD. N. DYER,

Attorney for Edison.* 11387

Jan. 13, 1883.

*Original is endorsed in pencil, "12, Jan. 13, '83."

Defendant's Exhibit "Edison's Divisional Application, No. 17."

S. M. H., Ex.

[*Oath of Invention.*]

STATE OF NEW YORK } ss: 11388
County of New York. }

THOMAS A. EDISON, whose application for Letters Patent for an Improvement in Incandescent Electric Lamps, (Serial No. 22,391, Edison's No. 264) was filed in the United States Patent Office on the 15th of December, 1881, being duly sworn, deposes and says, That he verily believes himself to be the original and first inventor of the improvement as described and claimed in the foregoing amendment, in addition to that which was embraced in the claims originally made: that he does not know and does not believe that the same was known or used before his invention thereof; and that the matter sought to be inserted formed a part of his original invention at the date of filing said application, of which this is a division.

Sworn to and subscribed before me }
this 18th day of January 1883. }

11389
Complainant's Exhibit "Edison's Divisional Application, No. 18."

S. M. H., Ex.

[*Rejection, March* 3, 1883.]

Room No. 91. (2-071.)

All Communications should be addressed to
"THE COMMISSIONER OF PATENTS,
Washington, D. C."

11390 DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., Mar. 3, 1883.

T A. EDISON,
Care R. N. DYER,
Menlo Park,
N. J.

Please find below a communication from the EXAMINER in charge of your application No. 22,301 for
11391 a Patent for improvement in Incandescent Lamps,
filed Dec. 15, 1880.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

The claims presented are rejected on the same reference and for the same reasons previously given against the cancelled claims.

Applicant may consider this a second rejection
of the present claims as they are substantially the
11392 same as those for which they were substituted.*

* Original is endorsed in pencil "13 Mar. 3 '83."

Defendant's Exhibit "Edison's Divisional Application, No. 19." 11393

S. M. H., Ex.

[*Appeal to Examiners-in-Chief.*

Thos. A. Edison,
Incandescent Elec. Lamps,
Filed Dec. 15, '80.
Ser. No. 22,301 (Edison's 264.)

TO THE HON. COMMISSIONER OF PATENTS:

In the above case, I hereby appeal to the Examiners-
in-chief, from the decision of the principal Exam- 11394
iner, and assign the following reasons of appeal:

The Examiner erred in deciding that the claims are anticipated by applicant's patents No's. 223,898 and 238,868, and that this case does not come within the rule laid down by the Commissioner in ex parte Maxim, decided Dec. 1st, 1881, (recorded vol. 22, p. 496).

It will be argued on appeal that the invention set
forth in this case is different from that covered by
either of said patents, and that said patents could 11395
not be re-issued to cover the invention in this case.

Also that such patents of applicant are not good references, for the reason that the application of which this is a division, was filed (Dec. 11 '79) before the grant of the first patent and before the filing of the application upon which the second patent was granted.

The Examiner erred in deciding that the patent
of Swan No. 233,445 and that of Maxim No. 230,-
310 anticipate the claims, for the reason that such 11396
patents do not claim the invention, and the application upon which such patents were granted were filed subsequently to the filing of the application of which this is a division.

11397 The Examiner erred in deciding that the description contained on page 605, Vol. LXX. of the Comptes Rendus, anticipates the claims, since such description relates to scientific experiments, not aiming to accomplish and not in fact accomplishing or even suggesting, the invention claimed in this case, or any part of it.

The Examiner erred in deciding that English Patent No. 3809 of 1872 anticipates the claims. This patent shows a form of lamp which was never made
11398 a practical success, and lacks the elements essential to success in incandescent lamps, which elements have been invented by applicant, and are claimed in this case. This patent does not have an inclosing chamber entirely of glass, or one hermetically sealed, or a carbon filament, or a carbon conductor that is flexible, or one of relatively great porosity and small mass, or leading-in-wires passing through and sealed into the glass.

11399 These are all distinctive features of essential importance in incandescent lamps.

Finally, the Examiner erred in deciding that English patent No. 12,212 O. L. anticipates the claims. This patent is open to all the objections of E. P. 3809 of 1872 as a reference, and to the further objection that carbon is not used at all, but metal iridium, for the incandescent conductor.

An oral hearing is asked.

Respectfully,

11400 RICHD. N. DYER,

Atty. for Edison. *

June 2d, '83.

*Original is endorsed in pencil.
"(14) Appeal to Board June 14, 1883."

Complainant's Exhibit "Edison's Divisional Application, No. 20." 11401

S. M. H., Ex.

[*Office letter, July 6, 1883.*]

(2—071) Room No, 91.

All communications should be addressed to
"THE COMMISSIONER OF PATENTS,
Washington, D. C."

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE. 11402

WASHINGTON, D. C., July 6th, 1883.

THOMAS A. EDISON,
Care RICHARD N. DYER,
65 5th Ave., New York City.

Please find below a communication from the EXAMINER in charge of your application No. 22,301 for a patent for improvement in Incandescent Electric Lamps, filed Dec. 15, 1880.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents. 11403

In an appeal to the Board of Examiner's-in-Chief filed June 4, 1883, and which is now before the primary examiner to make answer as per Rule 130, applicant, in the outline of argument he proposes to make before the Board, says:

"Also that such patents of applicant are "not good references, for the reason that the "application of which this is a division, was "filed (Dec. 11, 1879) before the grant of the 11404
"first patent and before the filing of the ap- "plication upon which the second patent was "granted."

From the record in this case it appears that this point has never before been urged by applicant or his attorney, and has never before been considered by the examiner. The question here raised for the first time in an appeal is one which may involve the fate of this case and is, therefore, of great importance. Now, without admitting or denying applicant's proposition, the examiner desires to consider the same, aided by any argument applicant may be inclined to present.

11405 For this reason, applicant is invited to withdraw his appeal so that the case may be returned to the jurisdiction of the primary examiner, for the consideration of the new point raised on appeal, as well as for the consideration of other points which may suggest themselves in the treatment of the case. *

* Original endorsed in pencil.
" 15
11406 July 6, '83. "

Defendant's Exhibit "Edison's Divisional Application, No. 21."

S. M. H., Ex.

11407 [*Appeal Withdrawn, July* 11, 1883.]

Thomas A. Edison,
Incandescent Electric Lamps.
Filed Dec. 15th, 1880.
Ser. No. 22,301 (Edison's No.)

TO THE COMMISSIONER OF PATENTS:

SIR:

In compliance with the request of the Primary Examiner, contained in his letter of the 6th inst., the appeal in this case is withdrawn to permit the
11408 Examiner to re-consider the pertinency of applicant's patents cited as references, and a reconsideration of the application upon this point is requested.

Respectfully,
RICHD. N. DYER,
Atty. for Edison. *

July 11, 1883.

* Original endorsed in pencil.
" 16
July 11, '83. "

Complainant's Exhibit Edison's Divisional Application, No. 22." 11409

S. M. H., Ex.

[*Rejection, Aug.* 10, 1883.]

Room No. 91 (2,071.)
All Communications should be addressed to
"THE COMMISSIONER OF PATENTS,
Washington, D. C."

DEPARTMENT OF THE INTERIOR, 11410

UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., Aug. 10, 1883.

THOMAS A. EDISON,
Care RICHARD N. DYER,
65 5th Ave., New York City.

Please find below a communication from the Examiner in charge of your application No. 22,301 for a Patent for Improvement in Incandescent Electric Lamps, filed Dec. 15, 1880. 11411

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Upon reconsideration of this case, the fact that this case is a division of an application (No. 187) filed Dec. 11, 1879, and now involved in interference has been duly noticed. It is self-evident that a part cannot be greater than the whole, and wherever this case contains by way of description or suggestion matter not contained in the original, it 11412
must be considered as transcending its legitimate scope, such additional matter being in the nature of *new matter*, and therefore objectionable. There is no doubt as to applicant's right to describe his original invention in a divisional application with greater accuracy than in the original application; he may with propriety dwell upon and emphasize the advantages of his invention, and call attention to the characteristics of its parts, more than in the original application, if he so desires; but it is not admissible to introduce *new matter* as distinguished from *new description*.

11413 For this reason applicant will be required to re-
move from this case all matter not found in the
original. As new matter is considered the refer-
ence in the specification to "an atmosphere of an
azotic or non-combustion supporting gas"—to
"other devices" included in the consumption cir-
cuit (p. 5, line 5)—to the use of other materials
than paper for the manufacture of the incandescent
conductor (p. 8, lines 3 to 9), and especially the
broad statement that any organic or inorganic
11414 material or compound, "structural or non-structu-
ral," which occurs in various parts of the specifica-
tion. The statements, that the material to be car-
bonized "may be mixed with carbon before car-
bonization," and also that "the filament may be
formed after carbonization," and that it is rendered
incandescent by an electric current during the
exhaustion of the globe, are also objectionable as
introducing *new matter* in this case.

11415 Claims 1, 2, 3 and 5 are held to be for the same
invention which is covered by the second claim in
applicant's patent No. 223,898, Jan. 27, 1880,
(Electric Lights, Incandescent). The carbon fila-
ment used in the lamp covered by the second claim
of the patent is made by the process of carboniza-
tion of (among other materials) paper, and if such
carbon filament is "flexible" and of "relatively
great porosity" as is predicated in this case, then
there is no reason why it should not have the same
11416 characteristics in the lamp shown in the patent. Two
patents for the same invention cannot be granted to
the same inventor, and the invention now claimed
in clauses 1, 2, 3 and 5 is held to be identical with
that shown, described and claimed in the patent
cited.

As to the fourth claim, it is found that its sub-
subject matter is identical with that of claims 3 and
4 in the application No. 187, of which this is a di-
vision; if it is intended to further prosecute this
claim, the equivalent claims in application No. 187
should be first erased.

Applicant's attention is also called to the fact, 11417
that the same claims (3 and 4) are also made by
Sawyer and Man, the parties with whom the inter-
ference of application No. 187 is pending.

As presented the application is rejected. *

* Original endorsed in pencil,
"17
Aug. 10, 83."

Defendant's Exhibit, "Edison's Divisional Application, No. 23." 11418

S. M. H., Ex.

[*Applicant's Letter, Oct.* 12, 1883.]

T. A. Edison,
Incandescent Electric Lamps.
Filed Dec. 15, 1880.
Ser. No. 22,301 (Edison's No. 264).

To the Commissioner of Patents.

Sir:

In the above case, the appeal having been with- 11419
drawn at the Examiner's request, for a specific
purpose, viz.: the consideration of the point set out
in the Examiner's letter of July 16th, 1883, regard-
ing the pertinency as references of certain patents
granted to applicant, and that point not having been
touched upon by the Examiner in his last letter,
but the occasion having been wrongly and unjustly
taken advantage of to raise entirely new objections,
excluded by and directly contrary to the conditions
upon which the appeal was withdrawn, notice is 11420
hereby given that the appeal will be considered and
treated as pending.

The Examiner is requested to withdraw his letter
of August 10th, 1883, and to answer the appeal.

Respectfully,
Richd. N. Dyer,
Atty. for Edison.*

Oct. 12, '83.

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*Original endorsed in pencil,
"18.
Oct. 12, '83."

11421 **Complainant's Exhibit "Edison's Divisional Application, No. 24."**

S. M. H., Ex.

[*Office action, Oct. 15, 1883.*]

Room No. 91. (2—071.)

All communications should be addressed to the COMMISSIONER OF PATENTS, Washington, D. C.

11422 Any communications respecting this application should give the serial number, date of filing, and the title of the invention.

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., October 15, 1883.

THOMAS A. EDISON,
Care Richard N. Dyer,
65 5th Ave., New York City.

Please find below a communication from the Ex-
11423 AMINER in charge of your application No. 22,301 for a patent for Improvement in Incandescent Electric Lamps, filed Dec. 15, 1880.

Very respectfully,
E. M. MARBLE,
Commissioner of Patents.

Applicant's letter filed Oct. 12, 1883, has been considered.

It appears that by office letter of July 6, 1883, applicant was "invited to withdraw
11424 "his appeal so that the case may be re- "turned to the jurisdiction of the primary "examiner, for the consideration of the new "point raised on appeal, as well as for the "consideration of other points which may "suggest themselves in the treatment of the "case.

In compliance with the request of the examiner 11425
the appeal in this case was withdrawn,

"to permit the Examiner to reconsider the "pertinency of applicant's patents cited as "references."

Thereupon, the case was re-examined, the pertinency of one of applicant's patents as a reference was re-asserted, but was explained upon grounds somewhat different from those heretofore taken by
the Office. The other references heretofore cited 11426
were not withdrawn, but were not particularly urged.

Besides this, the examiner considered other points which suggested themselves in the treatment of the case, and it was clearly his duty to do so, and the applicant was notified of this intention on the part of the examiner before the appeal was withdrawn.

The letter of rejection of Aug. 10, 1883, cannot be
withdrawn, and the application is now rejected 11427
a second time for the reasons stated and upon the reference cited in said letter.

Appeal upon the merits, and upon the basis of the rejection dated Aug. 10, 1883, may be taken to the Board of Examiners-in-Chief, and as to regularity of practice appeal may be taken immediately to the Commissioner of Patents.

The appeal to the Board of Examiners-in-Chief, dated June 4, 1883, being based upon actions of the
office which have since been modified or withdrawn, 11428
will not be considered.*

* Original endorsed in pencil:
"19
Oct. 15, 1883."

11429 **Defendant's Exhibit, "Edison's Divisional Application, No. 25."**

S. M. H., Ex.

[*Amendment of Dec.* 12, 1884.]

Thomas A. Edison.
Incandescent Electric Lamps.
Filed Dec. 15th, 1890.
Serial No. 22,301.

COMMISSIONER OF PATENTS:

11430 SIR:

In the above-entitled case, I submit the following:

Insert as additional claims:—

Sixth: An incandescing conductor for an electric lamp, of carbonized fibrous material, and of an arch or horse-shoe shape, substantially as set forth.

Seventh: The combination of an incandescing conductor of carbon for an electric lamp, of an arch or horseshoe shape, and a transparent hermetically
11431 sealed chamber, from which oxygen or other gases capable of combining with carbon at a high temperature are excluded.

Eighth: The combination of an incandescing conductor of carbon for an electric lamp, of an arch or horseshoe shape, included in and forming part of an electric circuit, and a transparent hermetically sealed chamber, from which oxygen and other gases capable of combining with carbon at a high temperature are excluded.

11432 *Ninth:* The combination, substantially as hereinbefore set forth, of an electric circuit, an incandescing arch or horseshoe of carbonized paper included in and forming part of said circuit, and a transparent hermetically sealed chamber in which the arch is inclosed.

The claims presented by this amendment are those of the application of Sawyer & Man for Improvement in Electric Lamps, filed Jan'y 9, 1880.

An interference is requested with that application upon the specific issues raised by the claims now presented.

Respectfully,

Dec. 12, 1884. RICHD N. DYER,
Atty. for Edison.

[*Edison's Oath of Invention.*] 11433

STATE OF NEW YORK, }
County of New York. } ss:

THOMAS A. EDISON, whose application for Letters Patent for an Improvement in Incandescent Electric Lamps, (Serial No. 22,301 Edison's No. 264) was filed in the United States Patent Office on the 15th of December, 1881 [1880?], being duly sworn, deposes and says, that he verily believes himself to be the original and first inventor of the improvement as described and claimed in the foregoing amendment, in addition to that which was embraced in the claims originally made; that he does not know and does not be- 11434
lieve that the same was know nor used before his invention thereof; and that the matter sought to be inserted formed a part of his original invention at the date of filing the application of which this is a division.

Sworn to and subscribed before me this day of

Complainant's Exhibit "Edison's Divisional Application, No. 26." 11435

S. M. H., Ex.

[*Office letter, Dec.* 20, 1884.]

Room No. 91. 2–071.

All communications should be addressed to
"THE COMMISSIONER OF PATENTS
Washington, D. C."

Any communication respecting this application should give the service number, date of filing, and title of invention. 11436

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., Dec. 20, 1884.

T. A. EDISON,
Care R. N. DYER,
N. Y. City.

Please find below a communication from the Examiner in charge of your application, No. 22,301

11437 for a patent for Improvement in Incandescent Electric Lamp, filed Dec. 15, 1880.

Very respectfully.

BENJ. BUTTERWORTH,
Commissioner of Patents.

The amendment filed Dec. 13, '84, has been entered of record, but the consideration of the new claims must be suspended until after the question of regularity of practice raised by applicant in his
11438 letter, filed Oct. 12, '83, and the question of applicants right to the claims rejected Oct. 15, '83, shall have been decided.

This case is now ready for appeal to the Commissioner on the first question, and to Board of Exrs-in-Chief on the second question, and it could serve no useful purpose to have the case still further complicated. After a 2d rejection, special amendments can only be admitted if applicant presents good and sufficient reasons why they were not
11439 earlier introduced, as provided by rule 67; no such reasons are presented, and the examiner must, therefore, refuse to consider the new amendment.

From this refusal appeal lies to the Commissioner in person.*

*Original endorsed in pencil "21. Dec. 20 | 84.

11440

Defendant's Exhibit "Edison's Divisional Application, No. 27." 11441

S. M. H., Ex.

[*Renewal of Appeal, Dec. 18, 1886.*]

Thomas A. Edison.
Incandescent Electric Lamps.
Filed Dec. 15th, 1880.
Serial No. 22,301. (Edison No. 261.)

TO THE COMMISSIONER OF PATENTS.

Sir: 11442

In the above case I hereby appeal to the Examiners-in-Chief from the decision of the Primary Examiner, stated in letters of rejection dated August 10th, 1883, October 15th, 1883, and December 20th, 1884, refusing to grant the patent in view of applicant's own patent, No. 223,898, dated January 27th, 1880.

This appeal is a renewal of a former appeal which was withdrawn at the request of the Examiner: it
is requested that the appeal fee which was then 11443
paid, and has not since been withdrawn, be applied to this appeal.

Preliminary to argument it is desired to state that after this appeal is disposed of, it is proposed to cancel the present specification and go back to substantially or identically the specification originally filed in the case. It is also proposed to erase the first claim, as being met by applicant's patent, and to cancel the third claim as being based on what might
be considered new matters of description. 11444

With respect to the remaining claims, it is urged that the matters covered by them are not described or claimed in applicant's patent referred to, and it is further urged, that this case being a division of and based on an application filed before the patent referred to was issued, such patent is not a good reference.

An oral hearing is asked.

Respectfully,

Attorney for Edison.

New York, December 18th, 1886.

11445 **Complainant's Exhibit "Edison's Divisional Application, No. 28."**

S. M. H., Ex.

[*Office letter, Jan.* 17, 1887.]

Room No. 91. (2–086.)
All communications should be addressed to
"THE COMMISSIONER OF PATENTS,
Washington, D. C."

{ U. S. PATENT OFFICE,
{ Mailed, Jan. 27, 1887.

11446 DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

WASHINGTON, D. C., January 27, 1887.

T. A. EDISON, Care R. N. Dyer, N. Y. City.	Application for patent for Incandescent Lamp. Filed Dec. 15, 1880. No. 50301.

Please find below a communication from the ex-
11447 aminer in charge of the application above noted.

M. V. MONTGOMERY,
Commissioners of Patents.

On the 20th ultimo, an appeal was filed in the above-named application to the Board of Examiners-in-Chief, or perhaps more properly speaking, the appeal of June 4, 1883, was renewed.

In this renewal applicant asserts that after the claims appealed upon have been adjudicated he will erase the present specification and return to the
11448 specification as originally filed.

Applicant is advised that under the decision of ex parte Silliman, 34 O. G., 1389, all preliminary matters must be settled before an appeal is taken to the Board of Examiners-in-Chief. It must be obvious in order that the board may be able to pass upon the questions in issue, the whole case should be in condition for allowance or rejection by them. In view, therefore, of ex parte Silliman above noted, the examiner refuses to entertain this appeal, and applicant is invited to make the proposed changes before the appeal is taken.

Defendant's Exhibit "Edison's Divisional Application, No. 29."* 11449

S. M. H., Ex'r.

[*Substitute Specification of Jan. 29, 1887.*]

Thomas E. Edison.
Incandescent Electric Lamps.
Filed Dec. 15th, 1780.
Serial No. 22,301. (Edison's No. 264.)

To the Commissioner of Patents. 11450

Sir:

In the above case, the following amendment is submitted in reply to the last official action:

Erase the amended specification and claims and insert—

The object of this invention is to produce an incandescent electric lamp, which shall render practicable a system of electric lighting, wherein a great number of lamps may be used, fed by current gen-
erated at, and distributed from one source located 11451
at what may be termed a central station.

Many attempts have been made to produce a practical electric lamp by causing an electric current to heat to incandescence a suitable conductor in an attempted vacuum, or in an atmosphere of an azotic, or non-combustion supporting gas, but no practically operative lamp has been devised therefor, before the date of my work upon this subject.

For such lamps it is now universally known that 11452
carbon is the preferable material for the incandescing conductor.

Such carbons, in the attempts hitherto made, have been of comparatively low resistance, ordinarily from two to four ohms, never exceeding five ohms, so far as can be ascertained from the records of the art, being quite thick and bulky relatively to their length.

* In the original of this Exhibit, at the top of this page, there are written, in pencil, these words: "Like original spec'n omitting underlined words."

11453 It has been customary to treat carbon for such use
in order to lessen its resistance, that is to take a
pencil of carbon, and increase its density and con-
ductivity by the filling up of its pores with other
carbons, for instance, by the deposition caused by
electrical incandescence due to a current traversing
such carbon while immersed in a hydro-carbon va-
por or liquid, or by soaking the carbon in a syrup,
or other liquid, rich in carbon, and then re-carbon-
izing. In fact the practice universally has been to
11454 reduce the natural resistance of the carbon, bring-
ing it to a relatively very low point.

This, from its attendant circumstances, has been
the main cause of failure of the attempts at incan-
descent electric lighting, the rationale of which may
be briefly sketched as follows:

It is essential in incandescent lamps that every
trace of free or combined oxygen, so far as possi-
ble, should be removed from the enclosing globe, in
order to prevent the disintegration or consumption
11455 of the carbon due to its being in contact with air.
With the means employed by me, it is possible to
attain a sufficiently high degree of vacuum to attain
this, were no air occluded in the carbon itself, or
were it fully carbonized. Air, or other gases and
watery vapor, and also hydro-carbon not decom-
posed in the original carbonization, containing
oxygen enough for the impairment of the carbon,
are, however, contained therein, and the carbon
must be treated in some manner to ensure freedom
11456 from this danger, and processes therefor have been
devised.

A carbon of low resistance, however, means bulk,
so much bulk that no process has yet been devised
which will remove entirely and in a commercially
practical manner the occluded air, or gas, or vapor
or hydro-carbon from such a carbon, the result be-
ing that from the carbon itself finally were freed,
under the influence of heat, the agencies which ulti-
mately caused its destruction.

As the greatest portion of the resistance in an 11457
electric circuit, to produce light at some point in
the circuit, must be concentrated at that point, a
low resistance carbon necessitated the use of con-
ductors thereto of very small resistance, which
meant such bulk of conductor, that, owing to the
different co-efficients of expansion of the conductor
and glass under heat, it was impracticable to seal
the conductor in the glass itself. In all attempts
hitherto made, the glass globe was therefore sealed 11458
by a foreign substance, sometimes metal caps with
composition thereover, sometimes combinations of
cements, gums, paraffin, &c., were used. When it
was attempted to produce a stable vacuum (which
attempt was seldom made) air inevitably penetrated
through such a seal, destroying the lamp. When
an artificial atmosphere was used, it has been found
practically impossible to maintain perfect joints
under the varying degrees of heat and pressure, be-
cause the expansion of the artificial atmosphere due 11459
to the heat of the luminous conductor expels a
portion of the same through any such sealing,
which is replaced, upon contraction by cooling, by
external air.

The large masses of conductor necessary to these
low resistance carbons were the means necessarily
of conveying large amounts of heat, endangering
the glass case, and the sealing thereof, so that it
became necessary to interpose non-conducting
plates, and to so construct the conductors, making, 11460
by twists, and convolutions, a great length thereof
in the lamp, so as to prevent the heat reaching the
glass and seal. Such experiments could not pre-
vent but only defer the effect for a time, and hence
were unavailing.

The necessary difference in the resistance of the
incandescing conductor, and the conductor supply-
ing the same before noted, necessitated in any at-
tempt at a system, the use of conductors of exceed-
ingly low resistance, which could only be obtained
by the use of a great mass of material.

11461 This involved the expenditure of so large a sum for mere conductors, that it was not deemed practicable to locate a number of lamps, or other devices for the translation of electricity into a visible effect, at a distance from the source of supply of the current; that is, this consideration negatived the idea of a general system of generation, distribution and translation.

With such carbon an absolutely perfect contact between carbon and clamps was necessary in order
11462 that there should be less resistance at the clamps than in the body of the carbon; otherwise a large heating effect would be developed there, destroying the clamps.

In addition, the low resistance carbon hitherto used has been unyielding and inflexible, with a considerable degree of expansion under the influence of heat, its degree or co efficient of expansion being different from that of its holders.

This unequal expansion of the carbon and its
11463 holders has resulted in fractures of the former, destroying the lamps, or in its working loose from its holders, so that perfect contact ceased, whereupon an arc was developed thereat instantaneously destroying the lamp. To obviate these dangers much ingenuity has been expended upon the carbon holders or clamps, so that they would maintain good contact, and at the same time allow for the expansion of the inflexible carbon. For such pur-
11464 pose spring contacts, roller contacts, etc., have been devised, but such expedients were either complicated or costly or unreliable. The unyielding and inflexible nature of the low resistance carbons heretofore used also rendered them liable to fracture from jars received in transportation, and when attached to structures subjected to undue vibration from any cause.

Moreover when it has been attempted to use such carbons in an artificial atmosphere, that is, in an azotic gas, it was found that there was a lower de-

gree of economy, that is, that fewer candle-power 11465
per horse power could be obtained than when a vacuum was used. Convective currents were set up in the gas by the heat of the incandescent conductor, heating the glass to a dangerous degree by carrying, and to a greater extent than when a vacuum was used. In addition, in such, and in any atmosphere, there is by the action of the current an absolute carrying of the carbon from one pole to the other, gradually destroying the carbon. The
amount of this action is directly dependent upon 11466
the amount of any atmosphere present, being practically nil in a perfect vacuum.

These faults, as before stated, have caused the failure of the attempts hitherto made to practically use the principle of incandescence in electric lamps.

The object of this invention is, to produce a lamp which shall obviate all these objections and faults, rendering practicable a system of incandescent electric lighting.*

In carrying my invention into practice, it is ne- 11467
cessary to manufacture carbon specially therefor, for in order to obtain the necessary resistance in a length permissible for use in a lamp designed for ordinary purposes, the carbon must be exceedingly small in cross section, so small that its dimensions are best expressed by applying to it the term "filament," it being thread like in size. Such a carbon cannot be made by reducing or cutting or forming bulk carbon. Moreover, such carbon is inflexi-
ble and unyielding. 11468

To obtain the necessary carbon, a carbonizable material must be cut or formed into the shape desired and then carbonized. For this purpose, paper is a very desirable material, the variety known as "bristol board" being especially so. The paper should be of the desired thickness, and as free as possible from foreign substsance, and adulteration

* In the original, in the margin opposite this point, there are the words, in pencil; "At this point the original statement of invention is omitted."

11469 With suitable instruments, such as a punch and die, I cut out a narrow strip of this paper, preferably in the form of an elliptical bow of [*or*] an arc of a circle, the ends of the strip being by preference wider than the other portions.

A number of these pieces of paper are laid flatwise in the bottom of a mold, preferably of wrought iron, and there is laid on them a light weight in the
form of a flat piece of gas retort carbon, or other
distorted
11470 device that will not be disturbed by the heat. If
several of these are laid one on the other in the mold, a piece of tissue paper is interposed between each one and the next.

A cover is used to cover the mold, and the mold raised very gradually to a temperature of about six hundred degrees Fahr. This allows the volatile portions of the paper to pass away, and at the same time the mold retains the paper in its proper shape,
and the paper is prevented from curling up or be-
11471 coming distorted, as it would be likely to do, if the
heat was applied suddenly, or the light weight dispensed with.

The mold is then raised almost to a white heat, and then removed and allowed to cool gradually.

The carbon filaments thus prepared will be found to have a very high resistance in small bulk, and to be very uniform in their resistance, and to be sufficiently strong for the handling attendant upon
11472 their embodiment in lamps and their use there-
in.

They will also be found to be very flexible, so that expansion and contraction resultant upon their heating and cooling when in use, may proceed without danger of fracture.

This flexibility also prevents fracture from jars to which the lamps are subjected in handling, and when attached to structures subjected to undue vibration. The flexible carbon filament of high re-

sistance, obtained as described, is then placed in an 11473
inclosing chamber of glass. This is done by sealing the leading-in wires of the lamp into the end of a glass tube by fusing the glass around the wires, the wires where they pass through the glass being of platinum. These leading-in wires are provided with suitable clamps in which are placed the enlarged ends of the flexible carbon filament. The filament is then passed into the open end of a glass bulb which is fused to the side of the glass tube
carrying the filament.* 11474

The glass bulb is then connected with suitable vacuum apparatus by means of a small glass tube projecting therefrom. A sprengel drop-pump is employed for the purpose. After a high degree of vacuum has been obtained, the flexible carbon filament is raised to incandescence by passing an electric circuit therethrough, and, by cutting resistance out of the lamp circuit, the degree of incandescence is gradually raised until considerably beyond
the degree of incandescence at which the lamp will 11475
be raised in use. This raising of the carbon filament to high incandescences during the exhaustion of the lamp drives the occluded gases out of the filament and clamps, increases largely the flexibility of the filament, and fixes its shape.

After the process of exhausting the lamp has been completed, the glass bulb is hermetically sealed, by fusing the glass tube leading to the air pump, and drawing the lamp away from the same,
when the lamp is ready fitted for use. 11476

In my patent No. 223,898 is described and shown a lamp which meets all the conditions of commercial manufacture and use, but has the disadvantage of being provided with a closely coiled fila-

* In the original there are written in pencil in the margin opposite this and the next three paragraphs the words: "Not in original."

11477 ment, parts of which do not radiate available light, but serve to heat other parts of the filament, resulting in an intensely concentrated light, which is disagreeable to the sight. The loop or horse-shoe filament of my present lamp is more convenient and economical in manufacture, and, radiating available light throughout the length of its incandescent portion, makes a lamp which is better adapted for general use.

11478 Desirable means for embodying the invention for practical use are shown in the drawings, in which,

Figure 1, is a vertical section of the lamp complete.

Figure 2, is a side view in larger size of the clamping device.

Figure 3, is a section at the line x, x in still larger size.

Figure 4, is the wire forming one of the clamps before it is bent up to shape.

11479 *Figure* 5, is the paper blank before it is carbonized.

The blank *a* is cut out of proper material such as "bristol-board" in the loop or horse shoe shape, and the carbonized as hereinbefore explained.

So treated it becomes the flexible carbon filament *i* which forms the light giving portion of the lamp when rendered incandescent by an electric current. It will be noted that these carbons are made with enlarged ends *a' a'* which are homogene-
11480 ous with the body of the carbon, the blank being properly fashioned therefor. These enlarged ends give an increased surface for the clamps which are to receive and support the filament, thereby ensuring a better electrical contact between them.

The lamp is made as follows: An enclosing globe *m* is made of glass with a neck *g* sufficiently large to permit the filament *i* to pass therethrough, opposite thereto a tube *k* indicated in dotted lines be-

ing formed. A supporting neck is made with an 11481
enlargement *n'*, equal in size to *g*, the top being finished as shown at *n''*. Through the top *n''* pass the wires which lead to the clamps supporting the carbon. The portion passing through the glass should be of platinum. These wires are sealed into the neck at *n''* by a melting of the glass around them, and they may be further sealed in, and protected if necessary by tubes A secured with *n* and sealed around the wires. Upon the upper end of the conductors the carbon is secured in proper 11482
clamps, which may be made of wire *h* at the ends of which are tips or small rivets *r* of platina or similar material. The wire is bent up and crossed as shown so as to act as a spring in clamping the end of the carbon filament that is placed within such clamp. The wire *h* passes through a small stock *o* into which the conducting wire *l* passes, and is clamped.

The carbon being secured in the clamps, and the clamps, stocks and conductors in proper position 11483
on *n*, the latter is introduced within the neck of the bulb *m* and the glass melted at *v*, the air is exhausted from the globe by the tube *k*, which originally is as shown by dotted lines, but which is melted together while the vacuum is maintained, when a proper vacuum has been secured as before set forth.

The lamp is now ready for placing in circuit, when the carbon is rendered incandescent by the current that passes through the same. It is dura- 11484
ble, as there is nothing to combine with the carbon, and it is substantially indestructible.

The result is the lamp shown in Fig. 1, a lamp in which the incandescent portion *i* is a flexible filament of high resistance flexible carbon, and in which all incandescing portions of the filament radiate available light.

11485 The high resistance permits of the use of conductors *l* so small that they may be safely sealed in the glass itself, avoiding the use of seals made of foreign substances, the lamp, although made of several pieces of glass, being now substantially of one piece of glass, so that the vacuum may be effectually preserved.

In addition it permits of the use of conductors from the source of energy to the lamp
11486 proportionately smaller, so that economy therein is subserved, which in practice means that a system is possible without that outlay in conductors which rendered hitherto the the idea of such a system impracticable.

It also allows of an even distribution of light among the lamps of a large system.

Further, the clamps that connect the conductors to the ends do not require to be pressed with much force on the carbon, because the resistance to the
11487 passage of the current between the clamps and the carbon will be less than the resistance of the carbon filament, hence but little heat will be developed at the clamps.

The flexibility secures it against fracture, and against disruption from its clamps, also permitting the lamp to be used in situations where there is jar or shaking which would forbid the use of ordinary carbons.

If the requisite high degree of vacuum be pro-
11488 duced the carbon is durable, as there is nothing in the lamp to combine with the carbon or to aid in the carrying of carbon before noted, and as the lamp is homogeneous, and of one piece, the vacuum is preserved and the lamp under normal usage, is practically indestructible at a medium incandescence.

This application is a division of my application 11489
No. 187, filed December 11, 1879.

What I claim is:—

First.—An incandescing electric lamp, having in combination, a hermetically sealed glass vacuum chamber, leading-in wires passing through, and sealed into the glass, and a flexible filamentary carbon conductor inclosed by such chamber, and connected with said wires, such carbon filament being constructed and arranged so that 11490
all incandescent portions will radiate available light, substantially as set forth.

Second.—An incandescing electric lamp, having in combination, a hermetically sealed glass vacuum chamber, leading-in wires passing through one side of such chamber and sealed into the glass, and a flexible filamentary carbon conductor, of a loop or horse-shoe shape,
inclosed by such chamber, and connected with 11491
said wires, such carbon filament radiating available light throughout its incandescing portions, substantially as set forth.

Respectfully,

RICHARD N. DYER,

Atty. for EDISON.*

New York, January 29th, 1887.

* Original is endorsed in pencil :
"24
Jan. 9, '87." 11492

11493 **Complainant's Exhibit "Edison's Divisional Application, No. 30."**

S. M. H., Ex.

Room No. 91.
All communications should be addressed to
"THE COMMISSIONER OF PATENTS.
Washington, D. C."

[*Office letter, Feb. 24, 1887.*]

11494 U. S. PATENT OFFICE,
Mailed Feb. 24, 1887.

WASHINGTON, D. C., Feb, 23d, 1887.

T. A. EDISON,
Care R. N. Dyer,
N. Y. City.

Application for patent for Incandescent Electric Lamps. Filed Dec. 15, 1880. No. 22,301.

Please find below a communication from the Examiner in charge of the application above noted.

11495 M. V. MONTGOMERY,
Comissioner of Patents.

After a careful consideration of this case, in connection with applicant's No. 187, Office No 146—30—filed December 11, 1879, now before the Commissioner on appeal from an action of the Examiner, and of which the present application is a division, and also in connection with applicant's No. 486, serial No. 81,854, filed January 15, 1883, the Examiner is convinced that there is no proper line of 11496 division, and that all the subject matter included in three applications should properly have formed part of the subject matter of the parent case, now on appeal as before stated. The lines of division appear to be entirely on the scope of the claims, and as the practice of the office has materially changed since the division was made, the Examiner now holds such division to have been improper (see ex parte Holt, 20 O. G., 177) and declines to consider the present case upon its merits until the questions involved in the original case are disposed of. *

* Original endorsed in pencil.
"(25) Feb. 23, 1887."

Defendant's Exhibit "Edison's Divisional Application, No. 31." 11497

S. M. H., Ex.

[*Request for Action, Feb. 21, 1889.*]

Application of Thomas A. Edison
Incandescent Electric Lamps
Filed December 15th, 1880.
Serial number 22,301 (Edison's No. 264).

TO THE COMMISSIONER OF PATENTS, 11498

Sir:

In the official letter in this case, mailed February 24, 1887, it was stated that the case would not be considered on its merits until the questions involved in applicant's prior case filed December 11th, 1879, which was then before the Commissioner on appeal, should be decided. The petition in the said prior case having now been decided, action on this case as last presented is asked.

In letter of February 24, 1887, the point is raised 11499 for the first time that this case is not properly a division of the said prior application, in view of changes in the practice of the office since the division was made.

I do not know what changes in practice are referred to, and am not aware of any rule of practice which makes this case an improper division.

If this objection is insisted upon, therefore, it is requested that the reasons for it shall be more fully explained and reference made to the rules or decis- 11500 ions of the Commissioner on which it is based.

The division was considered a proper one at the time it was made, and in all previous official actions it was treated as a legitimate division.

Respectfully,

Attorney for Edison. *

Dated, New York, February 21st, 1889.

* Original endorsed in pencil,
"26
Feb. 21, '89."

11501 **Complainant's Exhibit "Edison's Divisional Application, No. 32."**

S. M. H., Ex.

[*Rejection, March* 13, 1889.]

All communications should be addressed to
"THE COMMISSIONES OF PATENTS,
Washington, D. C."

U. S. PATENT OFFICE,
C. W. L.
Mailed Mar. 13, 1889.

11502

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE,

WASHINGTON, D. C., March 12, 1889.

THOMAS A. EDISON, Care: DYER and SEELY, No. 40 Wall St., New York City.	Application for patent for Incandescent lamp, Filed Dec. 15, 1880. No. 22,301.

11503 Please find below a communication from the Examiner in charge of the application above noted.

BENTON J. HALL,
Commissioner of Patents.

Room No. 91.

Referring to applicant's letter of Feb. 23 last, attention is again called to the decision of the Commissioner in ex parte Holt, 29 O. G., 171. The rule here laid down is that "Applications for let-
11504 ters patent are to be divided only upon lines drawn between separable and distinct parts of the thing invented."

The above is emphasized and reiterated by the later decision in ex parte Smith, 44 O. G., 1183, directing the Examiner to refuse to recognize or proceed with the examination of the divisional case.

The present claims Nos. 1 and 2 of this application, are regarded as covering the identical subject-matter embraced in claim four of applicant's case No. 146—30 filed Dec. 11, 1879.

The fact that the last named claim described a filament consisting of carbon made from "fibrous 11505
or textile material", has no effect in limiting or narrowing the invention set forth. A filament of any other character would serve perfectly as an equivalent so far as this combination is concerned. If applicant can make it clear that there are distinguishing features between these claims, he is requested to do so; but, meanwhile, the former action will be insisted upon, and no further action upon the 11506
merits will be had until the question of division is disposed of.*

* Original endorsed in pencil "27 Mar. 12, 1889".

11507

11508

11509 **Defendants' Exhibit "Edison's Divisional Application, No. 33".**
S. M. H., Ex'r.

In the Matter of the Application

OF

THOMAS A. EDISON for patent for Improvement in Electric Lamps and
11510 method of making the same, filed December 11th, 1879, and made [?] application of the said Edison for Improvement in Incandescent Electric Lamps, filed December 15th, 1880.

To the Honorable the Commissioner of Patents:

For the purpose of enabling you to prepare a
11511 proper return to the Order of The Honorable The Supreme Court of the District of Columbia, in the matter of the United States of America ex rel. The United States Electric Lighting Company *v.* Charles E. Mitchell, Commissioner of Patents, to show cause why a peremptory writ of mandamus shall not issue, commanding him to furnish the said papers as prayed for in the said petition upon which said Order was granted. I hereby authorize you, as attorney of record in the matter of the said applica-
11512 tions, to make such statements and admissions with regard to the same as may be necessary for the purpose of the said Return.

New York, April 30th, 1890. *

* Endorsed in pencil "28".

Defendant's Exhibit, Commissioner's Decision.—Ex parte Maxim. 11513

DEPARTMENT OF THE INTERIOR.

UNITED STATES PATENT OFFICE.

To all Persons to whom these Presents shall come,

GREETING:

This is to certify that the annexed is a true copy from the Records of this Office of the Decision of the Commissioner, December 14, 1881. 11414

Ex parte Hiram S. Maxim.
Subject-Matter:
Electric Lamps.

In testimony whereof I, C. E. Mitchell, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this 30th day of January, in
[SEAL.] the year of our Lord one thousand eight hundred and ninety-one, and of the Independence of the United States the one hundred and fifteenth.

C. E. MITCHELL,
Commissioner. 11515

U. S. PATENT OFFICE.

Ex parte Hiram S. Maxim. Electric Lamps. } Appeal from the Examiners-in-Chief.

Application filed March 31, 1881.
Messrs. Parker W. Page and M. Bailey for applicant. 11516

This is an appeal from the decision of the Board of Examiners-in-Chief affirming the decision of the examiner in holding that applicant should cover the subject-matter embraced in his present claims by the re-issue of his patent, No. 230,310, granted July 20, 1880.

The claims are:

"1. In an incandescent electric lamp the "combination with the conductors sealed

11517 "therein of a continuous conductor of carbon "gradually enlarged at or near its end substantially as and for the purposes set "forth.

"2. A continuous conductor of carbon for "use with an incandescent electric lamp consisting of the stem C having enlarged portion A, and gradually tapering portion B "substantially as and for the purposes set "forth."

11518 The latter ingredient, viz.: "the continuous carbon conductor gradually enlarged at or near its ends" is the essence of the invention. It is true that a carbon conductor having some of the characteristics of the device now claimed, forms one of the elements of the claim of the patent of applicant above referred to, but it does not, in my opinion, form the *essential* feature of the invention, such as is now specifically claimed.

Under the language of the statute, the Commis-
11519 sioner can only authorize a re-issue when the patent "is *inoperative* or *invalid* by reason of a defective "or insufficient specification" arising from inadvertence, accident or mistake.

It does not appear that the patent of applicant, No. 230,310, is inoperative or defective, nor that applicant inadvertently, through accident or mistake, failed to claim the device now sought to be patented. The device covered thereby is stated fully and clearly, and the claims embrace the invention disclosed in the specification.

11520 As stated by Mr. Justice Bradley (see case of *Manuf. Co. v. Ladd*, 102 U. S. Reports, 408),

"The mistake of the patentee seems to "have been in supposing that he was entitled to have inserted in a re-issued patent "all that he *might* have applied for and had "inserted in the original patent. * * * "A re-issue can *only* be granted for the *same* "*invention* which was originally patented."

I, therefore, am of the opinion that the Board of Examiners-in-Chief err in their decision that applicant's remedy is by re-issue. Each invention is complete and operative in itself and applicant is en-

titled to protection for both. 11521

"A re-issued patent is not valid for every- "thing which might have been claimed in the "original patent, nor does its validity depend "wholly upon the fact that the new features "attempted to be secured thereby were suggested in the models, drawings or specifications of the original patent." (See *Kells* v. *McKenzie*, decided November 7, 1881, 20 O. G., 1663).

The decision of the Board of Examiners-in-Chief 11522
is accordingly reversed.

December 14, 1881.

V. D. STOCKBRIDGE,
Acting Commissioner.

H. J. L.
W. I. J. P.

U. S. CIRCUIT COURT.

SOUTHERN DISTRICT OF NEW YORK. 11523

THE EDISON ELECTRIC LIGHT CO. vs. THE U. S ELECTRIC LIGHTING CO.	In Equity. No. 3444.

It is hereby stipulated that the decision of the 11524
Commissioner of Patents in *ex parte* Hiram S. Maxim, under date of Dec. 14, 1881, and marked in this case as "*Defendant's Exhibit*, COMMISSIONER'S DECISION *ex parte* MAXIM," is the decision referred to in the correspondence between Mr. Edison's attorney and the Patent Office, in the prosecution of Edison's Divisional Application of Dec. 15, 1880.

This stipulation is made subject to all legal objections on the part of the complainant that can be made against the use of the said decision in evidence.

R. N. DYER,
Of Counsel for Compl't.

S. A. DUNCAN,
Of Counsel for Deft.

A Note on the Sources

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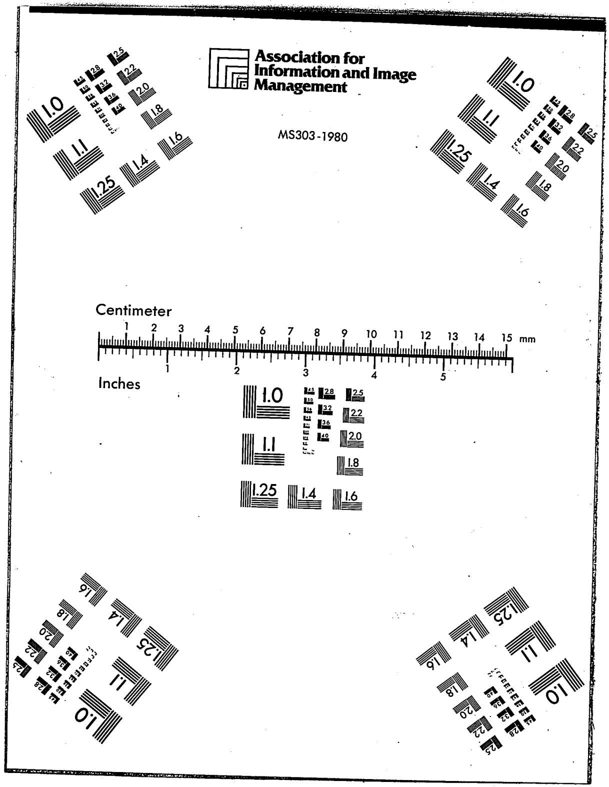
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